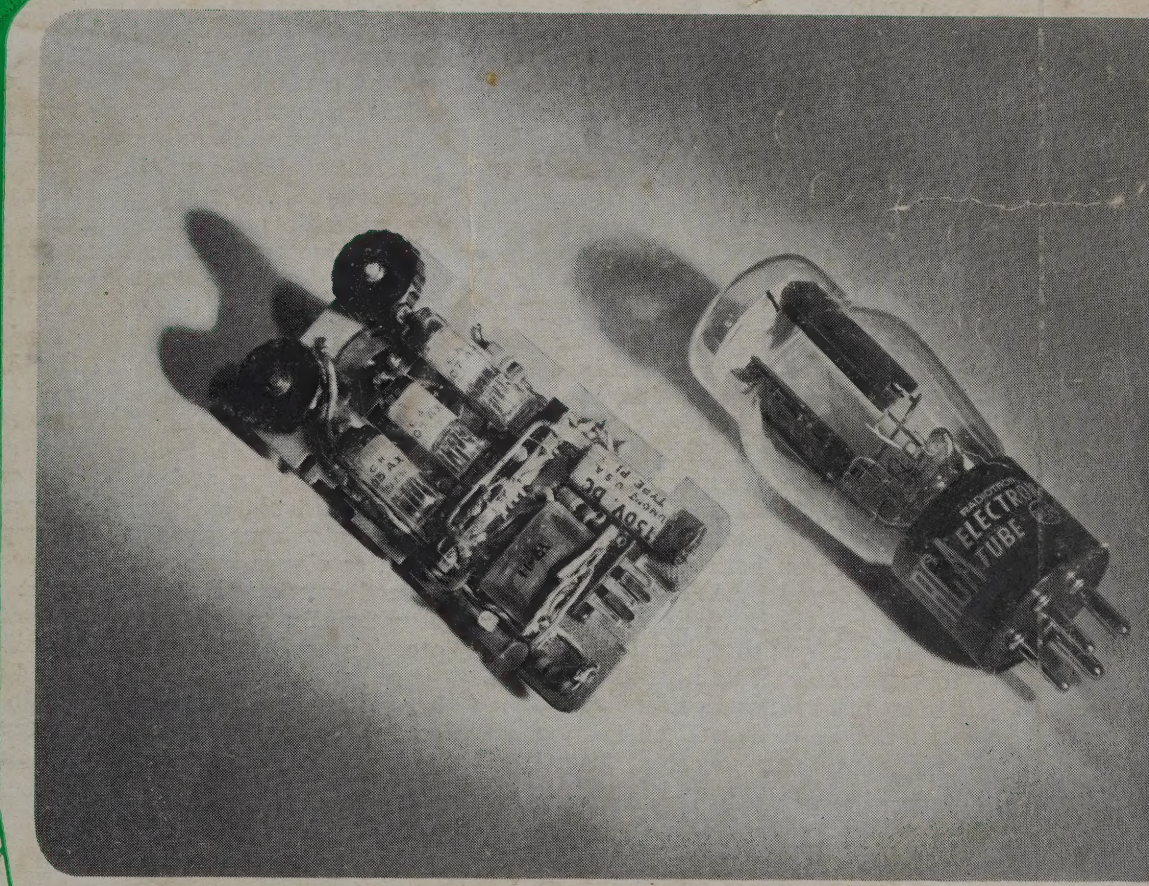
RADIO and ELECTRONICS



Included in this Issue:—

RADAR
A 10-METRE CONVERTER
THE RADEL FIVE

JULY, 1946

PROPAGATION AT 10 METRES
THE SERVICEMAN
QUESTIONS AND ANSWERS

1'6

Western Union Use . . .
P.V.C. PLASTIC INSULATION

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This insulation has been found by Western Union to afford valuable advantages over types previously used. Its high dielectric strength permits thin-wall, small diameter construction, and consequently allows for the insertion of a greater number of circuits in existing conduits. Because it is extremely flexible it can be employed on carriers in motion . . . and it retains this flexibility even at low temperatures. For wire and cable on overhead lines, P.V.C. plastic insulation furnishes protection against severe weather, and does not deteriorate when exposed to the photo-chemical effects of sunlight . . . and if wires and cables are lying on the ground or installed in industrial plants, this insulation protects them against the effects of acid or alkaline soils, oils greases, gasoline or alcohol. A specially important characteristic of this insulation, however, is its non-inflammability when properly formulated. Western Union engineers have found this insulation to be extremely valuable as a heat-resistant safety factor in built-up forms, where numerous conductors run in close proximity or in wire and cable installed in closed cabinets. This non-inflammable insulation is added protection if a cigarette is carelessly tossed upon wire and cable —although the cigarette may smoulder, the insulation will not burn. And, since it is produced in various bright colours to provide positive circuit identification in complicated assemblies, P.V.C. plastic insulation has added to the simplification of maintenance work. The millions of feet of wire used annually by Western Union attest to the importance of such simplification.

In addition to many applications such as office wire and cable and switchboard cord, Western Union uses P.V.C. plastic insulation on stock quotation ticker cables, outside wire and cable, and on instrument wire which is employed extensively on both stationary apparatus and carriages in motion.

Employed by Western Union as standard insulation during recent years, P.V.C. plastic insulation has contributed materially to the service life of wire and cable by providing long-lasting protection against chemicals abrasion and the elements. This insulation, however, is only one example of the broad use of plastics in communications systems. Other plastic applications which help maintain the high degree of service of Western Union's telegraph system are important components of branch office equipment, messenger service circuits, automatic circuits, and facsimile circuits.

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RADIO and ELECTRONICS

Vol. 1 No. 4 July, 1946

Contents Page

EDITORIAL 2
RADAR 4
HIGH-PERFORMANCE 10-METRE CONVERTER 6
QUESTIONS AND ANSWERS 11
PROPAGATION AT 10 METRES 13
A "5" SERVICE OSCILLOSCOPE 17
MICA MINING 25
THE RADEL A.C. BROADCAST FIVE 27
OUR GOSSIP COLUMN 33
THIS DX-ING 34
TRADE WINDS 36
FOR THE SERVICEMAN 39

OUR COVER

Our cover illustrates a Western Electric Hearing Aid, and for comparison is photographed beside a standard type 80 tube. The picture shows how modern electronic development has reduced the size of components, as this instrument contains three tubes, microphone, output transformer, and associated resistors and condensers.

●

CORRESPONDENCE

All correspondence, contributions, and enquiries referring to advertising space and rates should be addressed to:—

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NEXT MONTH. Included in next month's issue are:

For the Amateur: A Modulator which embodies new features.

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GUY E. MILNE
ELECTRONIC TECHNICIAN

What is Fidelity?

TO quote from a well-known text-book, "True fidelity is perfect reproduction of the original. Distortion is due to the addition of features not in the original, or the absence of features present in the original."

This statement (apart from the fact that "fidelity" is automatically "true") seems quite unassailable. It is the groundwork on which, for a number of years, designers have based all attempts to achieve perfection in the electro-mechanical reproduction of sound, and a very good foundation it has proved, to judge by the results achieved. But the fact remains that the performance of a reproducing system cannot be completely specified by means of electrical measurements alone.

This view, lest it may be new to some, is substantiated by engineers of the highest standing; it is an established fact that a system may approach perfection when judged by electrical measurements, and yet fail to sound better than another system, of somewhat inferior electrical characteristics.

Some people take this to mean that the design of reproducing equipment should no longer be carried out on sound engineering principles, since these have failed! These exponents of a wholly "cut and listen" technique often quote the case of the listener who, having been provided with a "high-fidelity" receiver, does not like the sound of it, and straightway turns the tone-control to "mellow." This argument, and others like it, are based on an incomplete understanding of the factors involved, and on the use of poorly-defined terms such as "high-fidelity."

Equally lacking in understanding of the problem are those who maintain stoutly that instruments cannot lie; that a system that approaches electrical perfection is the ultimate goal, even if listeners do not like the resulting sound. In this class comes the man who described the drop in sensitivity of the human ear at high and low frequencies as an "imperfection of the ear"!

Looking at the question from a rational point of view, the present state of affairs seems to be this: great advances in reproducing systems have been made by the application of pure A.C. theory to circuits designed to handle audio frequencies, but a stage has been reached where the purely electrical approach fails to effect any further improvement. This does not mean that the electrical approach is wrong, but merely emphasises the fact that insufficient is known of the mechanism of hearing. Until quite recently, for example, it was one of our cherished beliefs that the smaller the harmonic distortion introduced by a reproducing system, the more pleasing would be the resulting sound. Tests have shown that a system introducing substantially no distortion at all can sound flat, and lifeless, and that the introduction of controlled amounts of second and third harmonic distortion greatly increases the "life" and realism of the performance. However startling, this discovery by no means contradicts the normal principle that harmonic distortion should be kept to a minimum, since equipment with too little distortion is as yet hardly likely to be met outside the laboratory. It is safe to say that only in equipment where expense is no objection can the fullest use be made of all that has been discovered about sound-reproduction. All equipment available to the public must therefore be of compromise design, in one way or another. For this reason it seems unwise to lay down electrical specifications of the term "high-fidelity," as has been attempted. Doing so is an attempt to standardise something that defies standardisation, if for no other reason than the subjective nature of listening. Not until much more is known about human hearing will a technical specification of "fidelity" be possible. In the meantime, vague, indefinable terms like "high-fidelity" should be used sparingly, if at all, for they are misleading; they implicitly specify an "ultimate" which in practice cannot be found.

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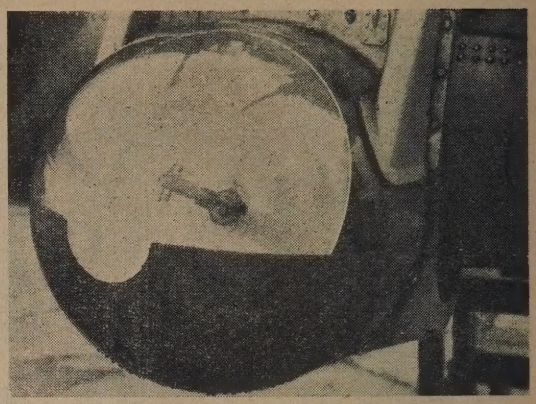
RADAR

Illustrated here is one of the later radar developments of the war, which helped in no small measure to protect our bombers while on their hazardous missions over enemy territory.

Although different in detail from the system of ground-controlled interception developed and perfected by the R.A.F., the German system was very effective, and at one stage German night-fighters were a very real menace to our bombers, both on the way to their targets and afterwards, when many of them were making a precarious way home, badly damaged by anti-aircraft gunfire.

Accordingly, radar was called upon to act as a tail-warning device, giving the crew notice of the approach of aircraft from behind. The first equipments used for this purpose did no more than warn the pilot (if he could) to take evasive action. But damaged aircraft are not always able to execute evasive manoeuvres, and it was quickly realised that a much more effective protection would be a rear gun-turret which could be trained by means of radar information, and would be ready to open an accurate fire as soon as the pursuing aircraft was recognised as hostile.

This, in brief, is the background of A.G.L.T., which stands for "automatic gun-laying turret."



The A.G.L.T. aerial scanner fitted to the tail of a Lancaster aircraft.

PRINCIPLE OF OPERATION.

Fundamentally, A.G.L.T. is similar to any other radar set in that it transmits pulses and receives back echoes from the target. It differs from other radars in the manner of presenting its information to the operator.

Since its signal frequency is in the micro-wave region, with a wavelength of only a few centimetres, a half-wave aerial and reflector are very small—only a few inches long. These are mounted near the focus of a parabolic reflector, and are made to rotate about the axis of the reflector in such a way that a narrow beam is rotated about the axis also. This in effect produces a cone of radiation with its apex at the aerial and an angle of about 40 degrees.

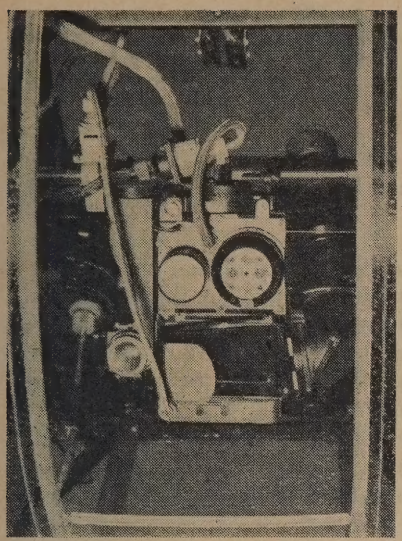
Synchronised with the rotation of the aerial is a rotary switch by means of which the receiver output is switched in turn to the four deflecting plates of the indicator cathode-ray tube. Each deflecting plate receives a signal only when the aerial is in the quadrant corresponding to that plate.

If a target is on the axis of the conical rotating beam from the aerial, the deflecting plates will receive equal signals, and the spot of the cathode-ray tube will remain in the centre of the tube. The circuits are so arranged that if the signal is stronger when the aerial is in any one position of its conical sweep, then the indicator spot will move to occupy a position corresponding to that of the target, the centre of the tube always representing the operator's position. The reflector we have described is mechanically linked with the rotation and elevation of the gun turret, so that, in order to train his guns on the target, all the gunner has to do is to turn the turret until the spot is centralised on the screen. And this, whether he can see what he is aiming at or not!

RANGE PRESENTATION.

So far no indication has been given to the gunner of the range of his target. In aerial gunnery ,and especially when radar aids are being used, it is more than useless to fire when the target is out of range, so that this information is equally important.

In this equipment no direct indication of range is given, such as one has in A-scope or P.P.I. presentation. This would be of very little use to a gunner in the heat of battle! Instead, electronic circuits are used which operate from range information collected by radar, and, as an end result, cause the spot on the gunner's C.R.T. to grow horizontal projections, so that the whole pattern very much resembles the front view of an aircraft, the spot being the fuselage and the horizontal pieces the wings. Now, as the target closes



The A.G.L.T. indicator equipment mounted on the gun turret. The black metal tube at the extreme right of the picture is the eyepiece through which target information is displayed in visual form.

in on the aircraft with the A.G.L.T., the "wings" appear while it is still out of range, and as it closes further, the wings grow wider. When they have grown to a size marked by two vertical lines, one on either side of the tube centre, the gunner knows that his target is within firing range.

The foregoing description gives some idea of how far radar devices have been developed in the way of giving a simple, unmistakable presentation of all the relevant information in such a way that a gunner, with a minimum knowledge of the principles of the device, may aim and fire his guns with almost certain success, without ever having seen his target.

In general, of course, he will attempt to identify the target visually before firing, for the latter may possibly be one of his own kind, following him home, rather than an enemy fighter, but this question is outside the scope of this particular radar to answer, and there are many things which will enable the gunner to obtain a fairly accurate idea as to whether or not his A.G.L.T. is showing him a "hostile." The astounding fact is that such a defensive weapon exists, when only a few short years ago most radio men, like "Little Audrey," would have laughed had such a possibility been suggested to them.

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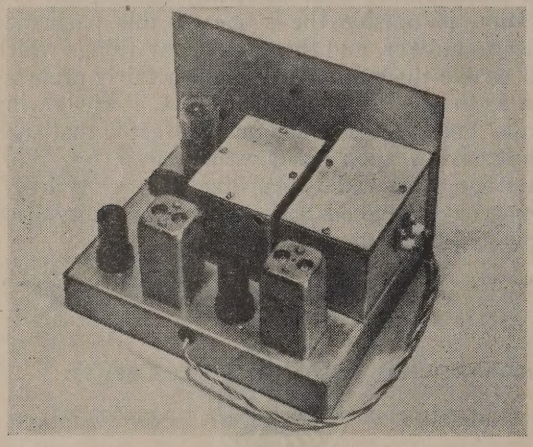
A High-Performance 10-Metre Converter

Described below is one answer to the question: "What kind of receiver for 'ten'?"

Since the ten-metre amateur band was re-opened earlier this year, there has been much discussion between amateurs as to the best type of receiver for this band. Some are in favour of winding extra coils to extend the range of existing receivers; others are building entirely separate receivers; while others again are building superheterodyne converters to use with the sets they employ on 80 metres.



The scheme of an entirely new receiver for ten metres has much to commend it. The best results on this frequency are seldom obtained by extending the frequency range, nor yet on communications-type receivers whose coverage extends to 30 mc/sec. The fact of the matter is that the tuning ranges and L/C ratios used on lower frequencies cease to yield good results at much higher frequencies than 20 mc/sec. The ten-metre band is the lowest on which the amateur feels this at all acutely, so that a separate receiver can be expected to give much better performance if for no other reason than that specially-constructed tuned circuits may be used, and will result in much lower losses.

Again, many receivers which go to 30 mc/sec. at their upper frequency limit suffer badly from image response. A separate receiver gives the designer a chance to remedy this defect by employing a high intermediate frequency.

The simpler types of band-spread used on many amateur receivers do not always allow enough spread to be realised on ten metres, but a separate receiver gives control of this factor, too.

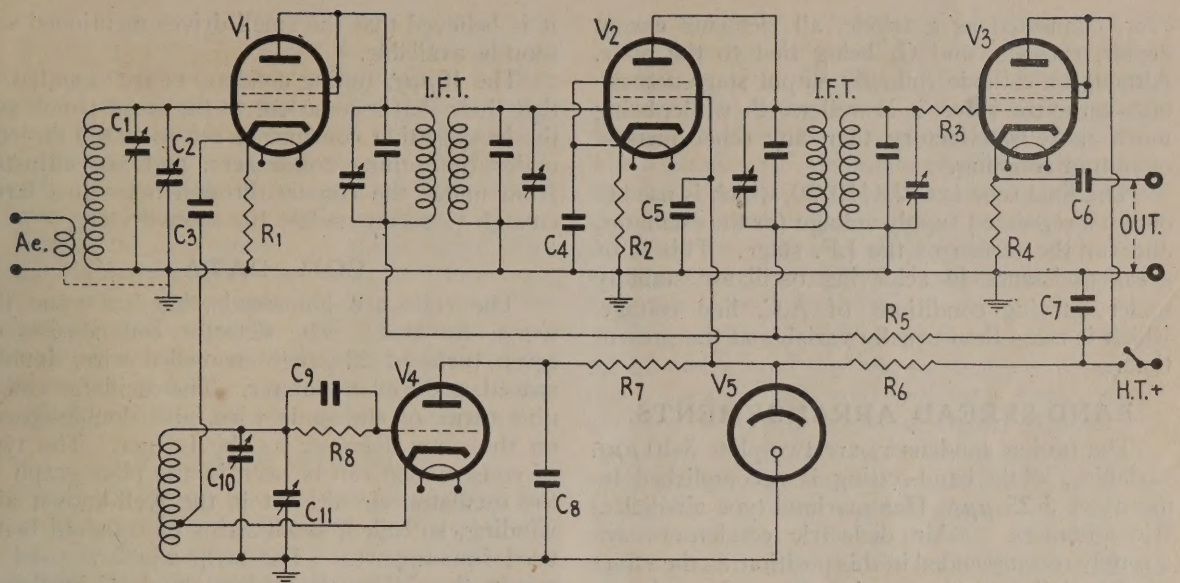
As against these favourable points, a receiver of the type indicated has certain disadvantages. The high I.F. makes it difficult to attain the required adjacent channel selectivity. The factor of expense, too, cannot be ignored, since such items as the B.F.O., audio amplifier, and power supply are a plain duplication of parts common to all receivers.

The latter alone causes the converter to be an attractive proposition, but when it is realised that all the desirable features of the main receiver are retained, while the use of a converter removes the disadvantages previously mentioned, many will find this the most desirable solution to a rather difficult problem. As an indication of what can be done in this way, "Radio and Electronics" has designed and built a converter which will be found entirely adequate when used with a receiver of even moderate sensitivity.

DESIGN FEATURES.

The converter uses a 6J7 as an infinite impedance mixer. This gives the whole system an extremely low noise-level. In our next issue there will be an article quoting actual figures proving this point. In fact, the omission of an R.F. stage in the converter is entirely justified, since the mixer noise is lower even than that of the 6AC7/1852. This being the case, no advantage is gained by using an R.F. stage, and we have the novel situation where the inherent noise in the first I.F. stage governs the noise level of the whole receiver.

For this reason, therefore, the converter includes a stage of I.F. using a 6AC7. Any other tube used in this position would increase the noise of the receiver as a whole, since this valve has a lower noise level than any of the normal R.F. pentodes such as the 6SJ7, 6SK7, etc. In addition, it gives much more gain owing to its high mutual conductance of 9 m.a./volt. This is a distinct advantage in case the converter is used with a receiver which itself has no R.F. stage, and starts with a 6K8 or similar mixer tube, which, unless it has plenty of gain ahead of it, will tend



C_1, C_{10} = 3-25 $\mu\mu f$. pre-set.
C_2, C_{11} = 3-10 $\mu\mu f$ variable.
C_3, C_9 = 100 $\mu\mu f$. mica.
C_4, C_5, C_7, C_8 = .1 μf.
C_6 = .001 μf.
R_1 = 100 k.
R_2 = 150 ω
R_3 = 500 ω
R_4 = 1000 ω
R_5 = 2000 v
R_6 = 2500 ω 5 w.
R_7 = 2500
R_8 = 25 k.
V_1 = 6J7.
V_2, V_3 = 6AC7/1852.
V_4 = 6J5.
V_5 = VR 150/30.
All resistors are 1 watt except R6, which is 5 watt.

to determine the noise level of the whole arrangement. It should be pointed out that the use of the infinite impedance mixer and the 6AC7 I.F. stage to provide the highest possible signal-to-noise ratio constitutes a very considerable advance over all previously published converters for 10 metres.

The frequency chosen for the I.F. is 4 mc/sec., which is high enough to give good image rejection and at the same time is very convenient for amateur use. In line with the realisation of the highest possible performance from the converter, the 4 mc/sec. I.F. transformers used employ air-dielectric trimming condensers of the Philips variety. The maximum tuning capacity in these units is very high—130 $\mu\mu f$., but this has been done with a definite purpose. In the first place, a high-C tuned circuit is desirable in the plate of the infinite impedance mixer, and secondly, the input and output capacities of the 6AC7 are much higher than those of the usual tubes, and it is an advantage to have these swamped by the circuit capacities. Finally, a low L/C ratio will reduce the gain of the 6AC7 stage to manageable proportions, and no difficulty will be experienced with this stage oscillating. This method of gain reduction is preferable to reducing the valve gain, since the latter method degrades the signal-to-noise ratio.

The oscillator is a straightforward Hartley circuit, using a 6J5. This is an excellent tube for high-frequency oscillators, and is used successfully even up to television frequencies, where the frequency of oscillation may be as high as 75 mc/sec. The only unusual feature here is that the oscillator frequency is lower than the signal frequency. That is, its tuning range must cover 24 to 26 mc/sec. for the amateur band at 28 to 30 mc/sec. This has been done in the interests of oscillator stability, which is easier to attain at lower frequencies.

A noteworthy feature is the use of a cathode follower as the output coupling device. This has the advantage of not loading the secondary of the final I.F. transformer to any extent, thereby increasing the selectivity, and at the same time giving a good match to the low impedance of the main receiver's aerial coil. The valve used is a 6AC7/1852, since at radio frequencies a high mutual conductance valve makes a much better cathode follower than the usual small triodes. It is, how-

ever, connected as a triode, all elements except heater, cathode, and G_1 being tied to the plate. Although a cathode follower output stage necessitates an extra valve, it is well worth while, being much more satisfactory than any other method of output coupling.

The final tube is a VR150/30, which is used to obtain a regulated supply voltage for the oscillator, and for the screen of the I.F. stage. This is of great assistance in achieving oscillator stability under varying conditions of A.C. line voltage, which is more than usually variable at the present time.

BAND-SPREAD ARRANGEMENTS.

The tuning condensers are two-plate 3-10 $\mu\mu f$. variables, while band-setting is accomplished by means of 3-25 $\mu\mu f$ Hammarlund type air-dielectric trimmers. Air dielectric condensers are strongly recommended in this position, as the effect of the ordinary compression type of condenser would be disastrous to stability, particularly of the oscillator. If the Hammarlund type of condenser is not available, or cannot be obtained, an alternative is the Philips type, such as the I.F. transformers use. With these condenser arrangements the 28-30 mc/sec. amateur band is spread over 90 to 100 degrees of the tuning condenser movement. If more bandspread than this is required, placing 10 $\mu\mu f$ silvered-mica fixed condensers in series with the tuning condensers may be tried.

CONSTRUCTIONAL DETAILS.

As can be seen from the photograph, the construction used is a little unconventional. The shield-box on the right is 5in x 3in x 3in, and contains the 6J7 grid-circuit components, and the tube itself. The shield-box in the centre of the chassis is 4in x 3in x 3in, and contains the oscillator stage. The 6J5 may be seen mounted on the side of the box. This puts all the oscillator components inside the box, allowing very short leads for the circuit and keeping the heat from the tube away from the components. This construction results in a minimum of drift and effectively isolates the strong oscillator fields from parts of the converter where they are not wanted.

It should be noted that the backs of the two shield-boxes are level with each other, leaving an inch between the front panel and the front of the oscillator compartment. This space is adequate for installing a small epicyclic reduction drive. In the prototype a small spring-loaded reduction drive was used, salvaged from a wrecked receiver, but it is believed that the small drives mentioned will soon be available.

The 10$\mu\mu f$. tuning condensers are mounted so that their shafts come out to the front panel, and the band-setting condensers are mounted directly under the tuning condensers, and are adjusted from under the chassis through holes just large enough to accommodate the screwdriver.

COIL DATA.

The coils are homemade, but are none the worse for that! The detector coil consists of seven turns of 23-gauge enamelled wire, double-spaced, and $\frac{3}{4}$in in diamter. The oscillator coil is nine turns of the same wire, also double-spaced on the same diameter as the former. The type of construction can be seen in the photograph of the oscillator circuit. It is the well-known air-winding, so called, small strips of celluloid being used for support. The strip which is used to mount the coil on the midget stand-off insulators is $\frac{1}{4}$in wide and the three remaining strips are one-sixteenth of an inch wide. The former used should be less than $\frac{3}{4}$in in diameter by an amount that compensates for the thickness of the celluloid. The strips are made about two inches long, for ease of working, and are tied at one end to the former with a piece of the coil wire. To wind the coil a sufficient length for twice the required number of turns is cut from the reel and stretched slightly to make it quite straight. The wire is then doubled, and the end is fixed by passing it between the $\frac{1}{4}$-inch strip and the former. The right number of turns is wound over the strips with the doubled wire, and the finishing end fixed in the same way as the starting end. This done, one of the wires is allowed to unravel, leaving the other accurately spaced by the wire diameter. The turns are fixed in position by a small amount of celluloid cement spread along the strips, and similar strips are stuck over the wire. When all is dry, the coil is slid off the former and the strips cut off close to the coil, except the mounting strip, which is allowed to project by $\frac{1}{2}$ inch at each end of the coil. Holes are bored for the bolts of the stand-off insulators, and the wires soldered to lugs, also held by the stand-off insulator.

The tapping point for the oscillator cathode is at three turns from the earthed end of the coil, and is made by scraping off enough enamel to allow a short piece of bare tinned wire to be soldered on. To prevent short circuiting turns next to the tapping, these may be pushed towards the axis of the coil with a screwdriver.

This type of coil construction is excellent from

all points of view. There is a minimum of insulating material to cause loss and, which is more important, temperature drift. The coils are very rigid, and will stand any amount of rough handling. And perhaps most important of all, their Q, actually measured at 30 mc/sec, was 220, which is quite a good figure for the frequency!

The aerial coil consists of three turns only, wound similarly to the other coils, and supported on two solid copper leads which come from the midget stand-offs used for aerial terminals. For most aerials the spacing of the aerial coil from the detector coil should be approximately $\frac{1}{4}$ inch, but this can be adjusted for best results on the spot.

I.F. STAGE WIRING.

There is nothing unusual in this part of the construction; I.F. transformers and the 6AC7 sockets should be mounted so that grid and plate leads fall naturally into place, with the plate pin as far as possible from the input transformer. The manufacturers' advice on the wiring of single-ended tubes should be closely adhered to if I.F. oscillation is to be avoided, particularly being careful to mount the screen bypass condenser across the socket so as to shield grid and plate pins from each other. It is most important, too, to decide on a suitable ground point for each stage, and take all earth leads belonging to that stage to the same point.

The output is taken from a single-conductor shielded plug and socket of the Amphenol type, and the lead run in shielded wire. This is most important, as if the output is taken from a single unshielded wire, most puzzling feedback and oscillation can be caused, even with the good layout illustrated.

PRELIMINARY ADJUSTMENT.

The lining up of the converter is very simple and no different from that of any other superhet. The power supply can be culled from any other piece of equipment handy—the main receiver being the best source, but in this case care should be taken not to overload the power supply, as the converter requires between 40 and 50 m.a. at 250 volts, and 1.5 amps at 6.3 volts A.C.

Lining up the 4 mc/sec. I.F. stage is best done in the usual way with a test oscillator. If this is not available, the heterodyne frequency meter or even the transmitter E.C.O. can be used. If none of these are available it can still be aligned on noise. To do this, the main receiver is tuned to 4 mc/sec., and the output terminals of the converter connected to the aerial and earth terminals of the receiver. Next, the grid-cap of the 6J7 is removed, and a 10,000-ohm resistor connected between grid and ground. The oscillator tube is removed, and the aerial connected to the 6J7 grid. The converter I.F. trimmers are then adjusted for maximum noise in the receiver output. This will take some care in carrying out, as the 30 $\mu\mu f.$ trimmers are only a small proportion of the total tuning capacity, and the adjustment can be expected to be quite broad.

Next, all that remains to be done is to locate the 10-metre band, and the converter is ready for use. Locating the band will be a little difficult unless a frequency meter or signal generator is available. With coils and condensers exactly as specified, the band-setting condensers will be set at slightly less than the half-meshed position in order to put 28 mc/sec. at the fully closed end of the 10 $\mu\mu f.$ tuning condensers. In adjusting the mixer grid circuit, the tuning condenser should be set at the same position as the oscillator tuning condenser, and the mixer band setting condenser rotated to give maximum signal.

No hard-and-fast rules can be laid down, since coils constructed by different people will be bound to differ slightly, but one thing should be guarded against. If the oscillator band setting condenser is at minimum and the mixer band setting condenser at or near maximum, it is possible to line up the converter for reception on 20-22 mc/sec., but this can be avoided by always ensuring that the band setting condensers are at approximately the same setting. When the band is located, it is best to arrange that 28 mc/sec. comes with the tuning condensers almost fully closed. If the tuning condensers are made to coincide in their setting at this point, and the mixer is peaked up with the band setting condenser, it will be found that mixer and oscillator tuning condensers track quite well. That is, correct adjustment at any point on the band will be had with corresponding settings of the two tuning condensers. This is desirable when stations have to be searched for, since the selectivity of the infinite impedance mixer is much higher than conventional circuits at this frequency. The measured image ratio of the converter at 29 mc/sec. was found to be 385 times, or 51 db., which is ample for amateur purposes, and proves that on this score an R.F. stage is quite unnecessary.

Before leaving the converter, just one more point about the aerial and oscillator coils. If it is found that your coils require some slight altera-

(*Continued on page* 38.)

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QUESTIONS and ANSWERS

L.A.E., Havelock North, writes: "I know that, practically, one may match an I.F. amplifier tube to its load, the I.F. transformer, and that the primary of the latter is said to have an impedance of so many ohms (usually thousands). Yet the impedance of a tuned circuit is

$$Z = \sqrt{R^2 + (\omega L - 1/\omega C)^2}$$

and as the reactance at resonance is zero, the impedance is $\sqrt{R^2} = R$, which is at the most perhaps 50 ohms. So how can a tube of several thousands of ohms impedance be matched to a load of only a few ohms?"

L.A.E. is apparently in a quite common quandary. The formula he gives is for the impedance of a series-resonant circuit, while the practical case he cites is that of a parallel-resonant circuit. The R in his formula applies to both cases, but represents the actual R.F. resistance of the coil. At resonance, a parallel resonant circuit with no losses would have an infinite impedance. In a practical case, the impedance is still high, but has a value related to the coil resistance by the relation

$$R' = \frac{L}{C R}$$

where R is the resistance in L.A.E.'s formula. R' is also equal to $\omega L Q$, and can be otherwise described as the imaginary resistance that would have to be shunted across a loss-less parallel resonant circuit to give it an impedance equal to that of an actual circuit whose coil has a resistance of R ohms. R' can be seen in practical cases to have a very high value, often approaching the plate resistance of a pentode amplifier tube.

T.R.J., of Dargaville, writes with a number of queries regarding the 6A3 amplifier which appeared in the first issue of "Radio and Electronics." He asks: (1) When feeding a crystal pickup directly to the input (with C_1 shorted), would there be any tendency for the 6SJ7 to overload on the loud passages?"

Only if the volume control were advanced too far. The amplifier is designed so that full output is obtained **before** the 6SJ7 overloads, so that normal adjustment of R, for suitable volume automatically prevents the 6SJ7 from overloading.

"(2) Would the amplifier give reasonable volume (say 8 watts at close talking) when worked directly from a srystal microphone? If not, would you suggest a suitable tube for a pre-amplifier?"

No. An extra stage will be necessary. For a diaphragm type crystal microphone a 6C5 resistance-coupled to the main amplifier should be sufficient, but for the sound-cell types a 6SJ7 would be suitable, with the same circuit values as are given for the one already in the amplifier. H.T. + should be connected to the same point as for V_1 of the main amplifier, but a filter using the same values as R_6 and C_7 should be interposed in the H.T. lead for the pre-amplifier.

"(3) Are the new midget 8 μf. smoothing condensers really reliable? Will they stand up to long periods of service and long periods of disuse without drying out or leaking?"

Yes. These condensers are quite reliable, and will stand up to long periods of use perfectly well. Any electrolytic condenser is liable to deteriorate if idle for long periods, but we know of no reason why the midgets should be considered any worse in this respect than "wets." We have had no experience of one leaking unless it had first been overloaded.

"(4) In your description, the field excitation arrangement is referred to as a compromise between magnetic field and voltage drop, which leads me to think that you are not quite satisfied with this yourselves."

In referring to the chosen field resistance as a compromise, we have simply stated a fact that applies to the choice of almost every component in any design. Any value chosen would be a compromise between these two things, so that what we really meant was that the choice of 1000 ohms is, in our opinion, the best choice among all values, any of which must be a compromise.

"(5) Would not an increase in transformer voltage, giving a higher H.T. voltage, allow a higher resistance speaker field to be used, giving more power to produce the magnetic field?"

Yes, this could be done if desired, the extra voltage drop in the new field winding providing the same H.T. voltage.

"(6) Apart from the above, would any additional advantages accrue from using, say, 350-400 volts on the 6A3 plates, with the bias resistor suitably increased to prevent excessive plate current?"

If this suggestion were carried out, a higher maximum power output could be obtained, but the following would have to be watched: (a) 362 volts for the H.T. voltage is the maximu mallowable, i.e., 300 volts

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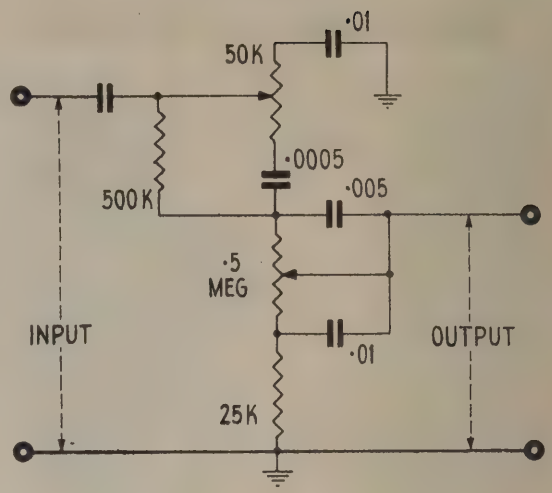
from plate to cathode and 62 volts bias from cathode to earth; (b) the product plate-to-cathode volts times plate current for both tubes should not exceed 25 watts or the life of the tubes will be reduced appreciably; (c) higher H.T. voltage will require higher excitation for full output at the new figure; this will take care of itself to an extent since the voltage-handling capacity of the 6SJ7, 6C5 stages will be automatically increased at the same time; (d) to obtain the best results a somewhat higher plate-to-plate load resistance will be needed for the 6A3's.

Sgt. R. Hanley, Nelson, writes: "Could you supply me with a diagram of a tone control to be incorporated in the amplifier described in your first issue? I have an electric guitar and require some means of obtaining a very deep tone and also a very sharp one."

We have succeeded in finding a circuit suitable to Sgt. Hanley's purpose, and take pleasure in printing it here, since the problem is one which will no doubt have occurred to others. This circuit should be incorporated between the pick-up and the amplifier input terminal. It will, however, introduce serious loss of signal amplitude which may have to be made up by using an extra stage of amplification. A 6C5, resistance coupled, should meet the case, and the suggested line-up is: pick-up—tone control network—6C5. The volume control may be left in the main amplifier in its present position.



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Propagation at 10 Metres

By propagation is meant the manner in which radio waves travel once they have left the radiating aerial and are, so to speak, left to their own devices. At one time, when not much was known about this, all that could be done was to ensure that an aerial radiated as efficiently as possible, and to see what happened. Then, the existence of an ionised layer of rarefied gas many miles above the earth's surface was not even suspected, and it was left to amateur enthusiasts to show that long-distance communication could be carried on on frequencies much higher than were being used commercially.

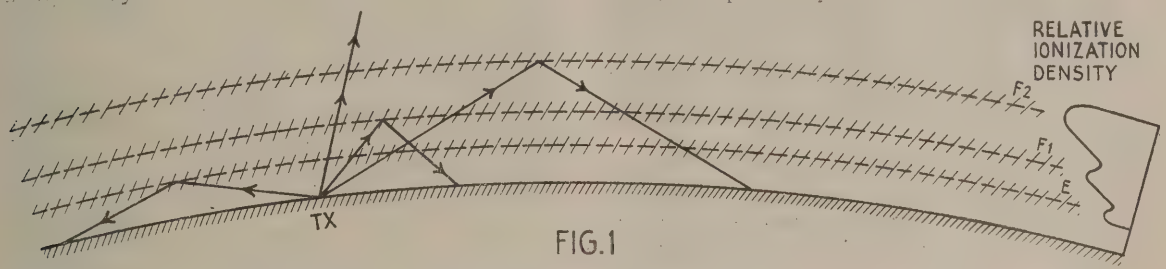

FIG.1

However, radio communication has come a long way since then, and many of the factors influencing communication over both long and short distances are now quite well understood.

When experimental 10-metre communication was first employed it was found that at times it was possible to work over world-wide distances with much lower transmitter power than could normally be used on lower frequencies. Amateur interest in "ten" ran high, and the band was hailed by all as the answer to the problem of DX operation in the daytime. Further work showed, however, that 10-metre operation was rather "patchy." From day to day, and even from hour to hour, results could not be depended upon. Signals could be at full strength one minute, and the next would have disappeared.

The reasons for this behaviour are quite numerous, and are connected with some of the lesser-known properties of the ionosphere, so it is not intended to go into them here. The purpose of this article is to show how 10-metre propagation takes place for long and short distances, and how amateurs may use present knowledge of the subject to obtain the best results on "ten."

THE IONOSPHERE.

Since all long-distance communication is dependent upon the ionosphere, we shall commence with a description of it. The ionosphere is so called because it consists of a region, covering the whole earth, where the gas molecules making up the atmosphere are ionised by the ultra-violet radiations from the sun. The region extends from about 40 to 60 miles above the surface of the earth to as far as there is any atmosphere. Even in the lower portion of the ionosphere the gases of the air are so rarefied that the pressure is little if at all greater than the pressure inside a valve! There is no need here to go into how the rarefied, ionised atmosphere returns radio waves to the earth, except to say that this behaviour is due to the influence of the free electrons in the ionosphere.

For reasons connected with the chemical and physical properties of the various gases making up the atmosphere, the ionosphere is not a continuous belt of ionised gas, but tends to become stratified. The regions where ionisation is a maximum are called "layers," and have been given names such as E, F_1 and F_2, since they can readily be identified, and each is responsible for some of the important effects of the ionosphere. Figure 1 shows these layers and their relative electron densities. It can be seen that between the "layers" the electron density does not fall off to zero by any means, and that the E, F_1, and F_2 regions are merely points where the electron density is greatest. Fig. 1 also shows some of the ways in which radio waves are reflected from these layers and returned to earth at great distances from the transmitting point. Some waves pass through the E and F_1 layers, and are reflected only by the F_2 layer, while others are reflected from the E layer. Others again penetrate all three layers and are not returned to earth at all.

The factors influencing the return or otherwise of a particular wave from a given layer are quite numerous and include frequency, time of day, height of layer, electron density of the layer and

the angle at which the wave impinges on the layer. In spite of this apparent complexity, methods have been worked out whereby all these factors may be taken into account, and a simple answer given to the question, "What frequencies will enable communication between A and B to be carried out at a given time of day?" To see how this desirable result has been achieved, it is proposed to enumerate the fundamental facts about ionosphere reflection.

PROPERTIES OF THE IONOSPHERE.

(1) The electron density of the various layers varies with the time of day.

This arises from the fact that ionisation is caused by ultra-violet radiations from the sun.

(2) The highest frequency that can be reflected by a given layer depends upon the electron density of the layer.

Thus, the highest frequency that a particular layer can reflect varies with time of day, because of (1).

(3) The highest frequency that can be reflected by a layer at any given time depends upon the angle at which the wave from the aerial strikes the reflecting layer.

This effect takes place in such a way that the greater the angle of incidence of the wave at the ionosphere, the higher the frequency that can be reflected.

(4) The height of any layer varies with the time of day.

CRITICAL FREQUENCIES.

The most important of these properties is No. 3, which may be further amplified as follows:—

For any angle of arrival of a wave at the ionosphere (all other factors remaining unchanged) there is a certain frequency above which all frequencies will penetrate, and below which all frequencies will be reflected. This is called the *critical* frequency for the angle of arrival specified.

Property (3) tells us that the greater the angle of incidence of the wave, the higher will be the critical frequency. This behaviour of an ionosphere layer is depicted in Fig. 2, where A is a transmitter on the earth's surface, and the lines drawn are various directions from A. On each is labelled the critical frequency for that path. It can be seen that the critical frequency for vertical incidence is lower than that for any other path. It is therefore the highest frequency that the layer will reflect at all angles of incidence. For this reason, the vertical-incidence critical frequency is called *the* critical frequency of the layer. It can easily be measured, and from it the critical frequencies for other angles of incidence calculated.

PRACTICAL APPLICATON.

Fig. 3 shows the earth, an ionosphere layer, and two points, A and B, between which it is desired to communicate. It is assumed that A and B are

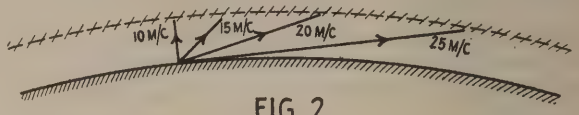

FIG. 2

outside the range of the ground wave (which on high frequencies is negligible), so that the ionosphere is the only link by which contact can be established. The shortest path which radio waves can take in travelling to B from A is via C, which is the point in the ionosphere midway between A and B, and could be the point of reflection. It can be seen from this figure why the angle of incidence at the ionosphere is so important, and why it has figured so largely in the discussion so far. The reason is that, for a given ionosphere height (and this does not vary very much), the angle of incidence is determined by the distance between A and B. Thus, the latter determines also the highest frequency that can be used at a given time. For, supposing the angle of incidence is 40 degrees, and the critical frequency for 40-degree incidence is 15mc/sec., this is the highest frequency that can be used at A in order to reach B.

If it is attempted to communicate with B on a higher frequency than 15 mc/sec., the waves leaving A at a higher angle of elevation than that shown on Fig. 3 will penetrate the ionosphere and will not return to earth at all. Those leaving at lower angles will be reflected, but will return to earth at points farther away than B. This behaviour is illustrated in Fig. 4, which shows two waves from A, one at a higher and one at a lower angle than the shortest path to B, both of them on a frequency of 20 mc/sec., at a time when the critical frequency for the path ACB is 15 mc/sec.

There is one term used in connection with the reflection of waves from the ionosphere which is often only partially understood, namely, "skip." The case we have used by way of illustration has demonstrated this phenomenon quite clearly. In Fig. 4, when 20 mc/sec. is being used, there is no contact with B because the waves leaving A at low angles are "skipping" over B and returning to earth at points beyond. In other words, B is

said to be in the "skip-zone" for 20 mc/sec. In Fig. 3, where the critical frequency for 40-degree incidence is 15mc/sec., B is at the inside edge of the skip zone, for 15mc/sec. will just be reflected at C and no more. AB is therefore called the skip distance for the frequency of 15 mc/sec. *The skip distance for a particular frequency can therefore be defined as the distance at which that frequency is the highest that can be used.*

In our discussion so far we have made use of the term "critical frequency" in a way that is not normally used in the literature. It has been pointed out that the critical frequency at vertical incidence is known as *the* critical frequency at the place under consideration. What has here been called the "critical frequency for 40-degree incidence" is usually known as the "maximum usable frequency," and is usually referred to the places between which communication is desired. For instance, in Figs. 3 and 4, 15 mc/sec. is the maximum usable frequency for communication between A and B, and if other things were equal, any frequency lower than this would enable communication to be carried on. Henceforward the term "maximum usable frequency" will be used, and "critical frequency" reserved for its proper use at vertical incidence only.

THE IONOSPHERE AT 10 METRES.

The foregoing description has been very brief, and a great deal of material has been omitted, such as a description of the relative roles played by the E, F_1, and F_2 layers. All that has been said so far applies equally well to all three layers. It is convenient at this point, however, to branch out and deal with the effects of the ionosphere on 10-metre communication.

First, it is the highest layer, the F_2, which is responsible for reflecting frequencies as high as 30 mc/sec. In the usual course of events the critical frequencies of the E and F_1 layers are too low for a maximum usable frequency as high as this ever to occur. (There is an effect called "sporadic E," in which the E layer sometimes reflects much higher frequencies than usual, but, as its name suggests, it cannot be used for reliable communication.) At a given time of day, the critical frequency of the F_2 layer is almost always higher than that of the other two, and, because of this, and in addition because the F_2 is higher up than the others, this layer enables very long distances to be covered in a single "hop" from earth to ionosphere and back. As the reader will have gathered, longer distances require higher frequencies, so that, conversely, the higher frequencies are suitable for longer distances. The longest distance that can in practice be achieved with a single "hop" is about 2500 miles. This corresponds to an angle of departure of the wave from the earth of only three degrees or so.

Thus, for the very long distances, two, three, or even more hops take place. In addition, or rather as a consequence, there are a number of skip zones possible with multi-hop transmissions.

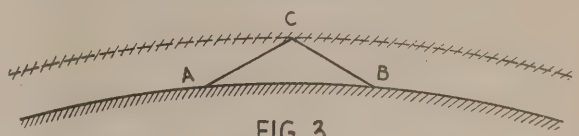

FIG. 3

Now, at a given time, the characteristics of the ionosphere vary from place to place, so that when multi-hop transmission is attempted, there is a maximum usable frequency at each reflection, so that the actual frequency used must be lower than the maximum usable for any of the hops involved.

As can be seen from the foregoing, conditions for long-distance working can be rather complex, at least in theory. In actual fact, the considerations so far presented reduce to a few quite simple requirements.

(1) For long distances (2500 miles or greater) aerials should be used which concentrate as much radiation as possible to low angles of elevation.

This follows from the fact that the only energy reaching the receiver will do so by paths leaving the transmitter at low angles, between 3 and 10 degrees above the horizontal. In addition, on 10 metres, high-angle radiation will penetrate the F_2 layer and be wasted.

(2) For medium distances, say 1000 to 2500 miles, angles of radiation up to about 15 degrees may be used, so that most purposes will be served if the main lobe of the aerial has its maximum radiation at about $7\frac{1}{2}$ degrees. This will give useful radiation at very low angles and at angles up to about 12 degrees.

(3) For short-distance communication on 10 metres, it is hardly ever practicable to use ionosphere-reflected waves in latitudes as high as New Zealand.

This is because critical frequencies in general are highest near the Equator, and become lower towards the Poles. Short-distance communication is therefore restricted in very much the same way as is five-metre work to optical ranges. If short-range working is desired on "ten," the same principles should be followed as are used on five metres and shorter wavelengths.

TIMES OF DAY.

Earlier in this article it was mentioned that the electron density of a layer varies with time of day. This means that critical frequencies, and therefore maximum usable frequencies vary in the same way.

The ionisation density of the F_2 layer is at a maximum round about midday, so that, in general, critical and maximum usable frequencies are highest at that time also. Thus it follows that between 10 a.m. and 2 p.m. are the most likely times at which very long-distance communication is possible on 10 metres. There is usually a pronounced drop in critical frequency in the vicinity of dawn and dusk, so that these are the least likely times for very long-distance work on 10. It should be realised, however, that these are broad generalisations, and, though certainly true, exceptions may often be found, in that on some days exceptionally good or bad conditions may be found at times that are quite outside those given. The "sporadic E" effect, for instance, sometimes enables quite unpredicted long or even short-distance communication to take place.

ANNUAL VARIATIONS.

In addition to daily variation, the ionosphere is subject to a yearly variation which also affects communication. Broadly speaking, critical frequencies are higher in midsummer than during the rest of the year, and are lowest in midwinter. Referring again to 10-metre work, this means that long-distance communication will be possible more often in summer than in winter. Already this effect is making itself felt, for, as amateurs are aware, conditions on "ten" are not quite so lively now as they were a few months ago when the band was re-opened.

THE ELEVEN-YEAR CYCLE.

Great interest has already attached to the present high sunspot activity, and to the fact that we are approaching the period of greatest sunspot activity. This activity has a particularly great effect on 10-metre propagation, since the ionosphere follows it exactly, and the highest critical frequencies are found to exist at the times of greatest sunspot activity. The latter follows a cycle 11 years in length, so that every 11 years also there is a maximum in the critical frequencies of radio waves. The sunspot maximum is in about three years' time, so that until then we can expect increasingly good DX on 10 metres each summer.

Since for some time these cycles of ionosphere behaviour have been known, and critical frequency measurements have been taken, it was possible during the war years for laboratories, specially set up for the purpose, to forecast month by month with considerable accuracy, what the critical frequencies and maximum usable frequencies would be, all over the world, for communication over all distances. This information, at the time, was confidential, but it is now unrestricted, and it is believed that before long anyone will be able to purchase the graphs containing all this information. This should be a boon to amateur transmitters, just as it has been to the armed services, broadcasting services, and the Post and Telegraph Department. By perusing the appropriate curves, it will be possible to tell at a glance at what times the various amateur bands will be workable over various distances. If nothing else, this will save

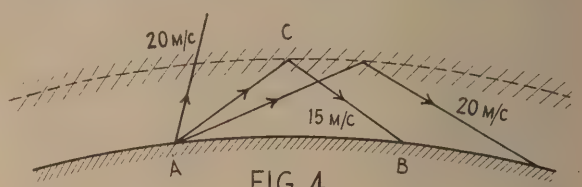

FIG. 4

endless sitting up trying to make contacts that are physically impossible! It will be possible for amateurs to work out with very little trouble what will be the best times to listen on the various bands for signals, say, from Australia or America. Although this will apply to 20 and 40 metres, and to some extent to 80, by far the most useful information will be given about 10 metres. This is because the curves showing maximum usable frequency against time of day are usually quite steep at the times when the highest frequencies are coming in and out of use. This accounts for the characteristic of 10 metres mentioned at the beginning of this article, whereby one minute it gives good results, and the next, signals disappear. The curves referred to therefore indicate very conclusively at what time the highest frequencies come in and go out. On particular days the actual times found may vary from this by half an hour to an hour, but very seldom by a greater margin.

TEN METRES FOR DX.

Why is it that such excellent DX results are often obtained on "ten" with very low-powered transmitters? The answer to this is also connected with the ionosphere, by a point which has not yet been made in this article. It is this:—

(continued on page 37)

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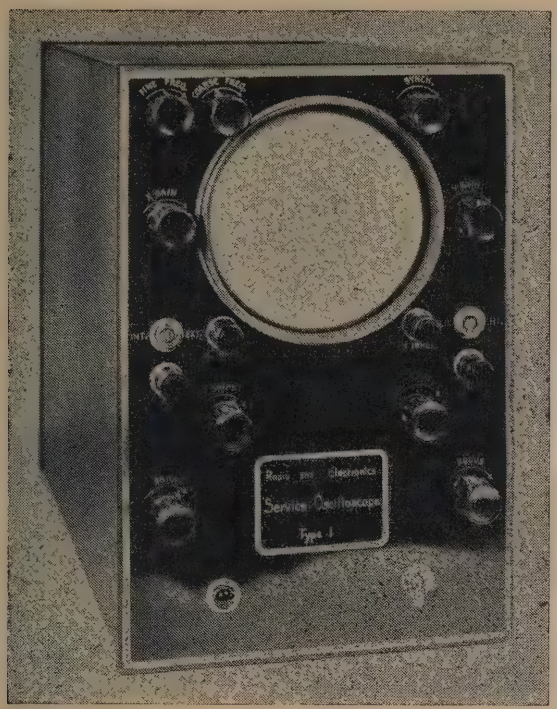


PART III.—THE REST OF THE CIRCUIT.

In Parts I and II of this article all parts of the circuit have been described with the exception of V_4, V_5, V_6, V_{11} and V_{12}, so that these will be dealt with before describing the layout and setting up of the oscilloscope.

THE Y-AXIS AMPLIFIER.

V_5 is a conventional voltage amplifier using a 6J5, under normal resistance coupled conditions. SW_1 is the High/Low Y gain switch. When the latter is in the left-hand position, C_{11}, R_{28}, and R_{30} are returned to earth in the usual way and full gain is realised frim V_5. When SW_1 is turned to the right, R_{29} is inserted into the cathode circuit. This introduces negative feedback, reducing the gain of V_5 to approximately 1. R_{30} is thus enabled to act as an attenuator when high voltage signals are applied to the Y input. The Y axis is thus enabled to handle inputs from a fraction of a volt to about 200 volts. In addition, in the low gain position the Y axis input has almost the same gain as the X axis, which facilitates the production of Lissajous figures when the oscilloscope is used for measuring audio frequencies.

V_4 is a 6N7 with sections connected in parallel and used as a cathode follower. The purpose of this tube is two-fold. First, it enables the long lead from the output of V_5 to the input of V_2 to be run in shielded cable without introducing appreciable high frequency loss. Secondly, by making its cathode load R_{26}, a potentiometer, variable amplitude signal voltage is fed to the grid of the time-base valve. R_{26} is therefore the synchronisation control. The transition time-base is very sensitive to synch-voltage fed to the grid, and for this reason the signal is taken off after only one stage of amplification.

A possible criticism of this circuit is that each time the Y-gain control R_{30} is moved, the amplitude of the synch-voltage is altered. In practice, this is no disadvantage, as a change in Y amplitude of about 2:1 is required before the picture falls out of synchronism. In fact, if the picture consists of three or more cycles of the work-voltage, it does not fall out of synch. at all. All that happens is that one cycle is added to or taken from the picture, which remains quite stable. The non-critical nature of the transitron with regard to synchronisation is a very pleasing feature of the circuit.

According to calculation, the Y channel as a whole should have a flat response up to 100 kc/sec. Although this was not measured, it would appear to be so, since usable response is still obtained as high as 1 mc/sec.!

THE X-AXIS CATHODE FOLLOWER.

This uses a 6J5, and was included because there is a long signal lead between the front panel where the input terminal is, and the input to V_3, which is at the extreme rear of the chassis so as to be near the C.R.T. socket. SW_2 changes the input to the X cathode follower from the time-base valve to the X-input terminal, so that external sweep voltage or signal voltage may be connected if desired.

For simplicity's sake, no provision has been made for stopping the time-base when SW_2 is switched to the external position. In the prototype, SW_2 was an ordinary single-pole-double-throw toggle switch. This type has quite a high capacity between contacts, so that if the time-base is on one of the high-frequency ranges while SW_2 is on the the "External" position, a small amount of time-base voltage feeds through the switch capacity. This may be prevented by turning the

time-base coarse frequency control down to the lowest range, when the frequency is too low for the switch capacity to allow it through.

THE BLACK-OUT TUBE.

As was mentioned earlier, V_7, as well as producing the time-base saw-tooth voltage, has at the screen a positive-going pulse which lasts for the exact duration of the fly-back. If this pulse is fed in the correct polarity into the grid-cathode circuit of the C.R.T., the beam will be extinguished for the duration of the pulse, so that the fly-back is no longer seen. If desired, C_{34}, R_{60}, and the whole of the circuit belonging to V_{11} and V_{12} could be omitted from the scope. However, this is not recommended, as the fly-back is very easily seen and can be confusing to one not used to the interpretation of oscillograph figures.

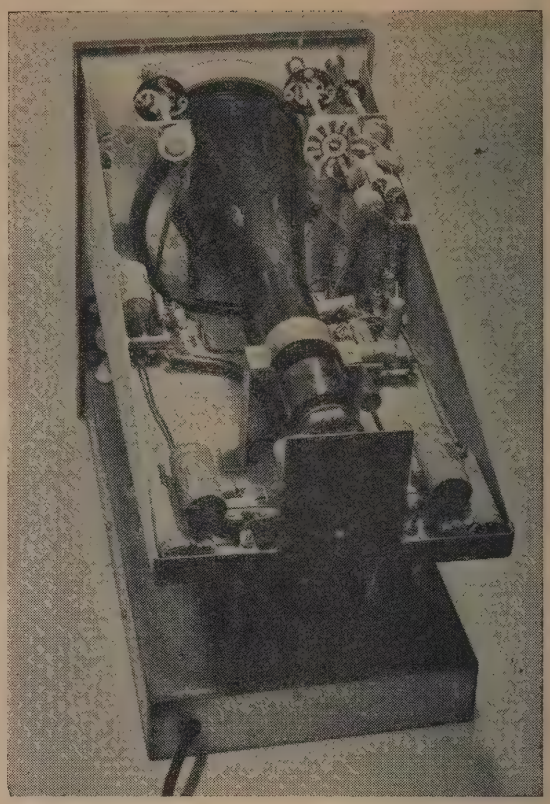
The 5GP1/5BP1 has its cathode internally connected to the heater winding, so that brilliance control voltages must be fed in on the grid. The black-out waveform from V_7 is therefore of the wrong polarity, and is therefore phase-inverted by V_{11}. The output of this tube goes to V_{12} which is a cathode follower, whence it is fed through C_{34} to the C.R.T. grid.

This black-out circuit is the only portion of the scope that is at all critical as to values (except the 6AC7 time-base) and since no two C.R. tubes have identical characteristics, a little experiment may prove advantageous. C_{34} should have 1200v. rating, which makes it an expensive item, but a scheme may be used to get over this difficulty. .005 μf. buffer condensers for vibrator power supplies may be obtained at reasonable cost, and can be used as C_{34}, with one slight disadvantage. If this is done, the last quarter or so of the fly-back will be visible on the lowest frequency range of the time-base. In addition, the first portion of the trace proper will be extra-bright, and may be slightly out of focus. If the effect is only slight, it may be justified on the grounds of extra expense for a large 1200v. condenser.

There is another effect that may have to be overcome when putting the black-out tube into operation. With some tubes, the full output voltage of V_{12} may be too great, so that the trace is too brilliant, even with the brightness control at minimum. If this is the case, it is worth while to make R_{59} a 50k. potentiometer and to set it so that the fly-back just becomes invisible, while the increase of brightness of the trace proper is only slight.

CONSTRUCTIONAL FEATURES.

So far, we have described only the circuits



used in the oscilloscope, but no less in importance is the mechanical layout. The pictures in Part II of this article, and the present instalment, give a good idea of the construction of the original model. This is novel, to a certain extent, in that two chassis are used, and one of these is inverted. The lower chassis carries the power supplies only, and the top tray holds the tube and all signal and time-base circuits. One advantage of this method of construction is that the top chassis acts as an electromagnetic shield for the tube and helps to prevent hum pickup from the power transformers. Even so, it is advisable to fit an iron shield round the cylindrical part of the cathode ray tube. If this is done there is very little chance of magnetic hum-pickup. In addition, inverting the tubes on the top chassis makes it possible for the complete chassis to be constructed as one piece before wiring up is begun, and gives ready access to all components should the scope require servicing at any time.

The two tubes at the back of the top chassis are the 6N7 cathode-coupled stages, and are placed as close to the C.R.T. socket as possible. Looking from the front of the chassis, the tubes on the right, reading from front to back, are V_5 and V_4.

On the left are V_6 at the front, V_7 behind it, and $V_{11}+V_{12}$ behind that again.

On the right or Y-side, the tall bracket supports the potentiometer R_{26}, whose shaft is the synch.-control. On the X-side can be seen SW_3, the coarse frequency control, and R_{38}, the fine frequency control.

Referring to the photograph in Part II of this article, the Y-shift control may be seen on the front panel, just to the left of V_5, while the potentiometer on the insulating board underneath is the focus control. In corresponding positions on the X-side are the X-shift control and the brilliance control. The two potentiometers mounted along the left-hand edge (in the picture) of the bottom chassis are R_8 and R_{11}. The astigmatism controls R_{21} and R_{41} are mounted as close as possible to the sockets of V_1+V_2 and V_8+V_9, respectively. The former may just be seen in the photograph under the near left-hand corner of the top chassis. The photograph with this instalment gives an idea of the layout of parts on the top chassis. The shielded cables from V_4 to V_2 and from V_6 to V_8 can be seen on their way down the chassis, as can the cable from R_{26} to V_7. The time-base condensers C_{14} to C_{19} can be seen grouped to the right of SW_3.

It should be noted that the bypass condensers belonging to the cathode-coupled stages are all mounted on the top chassis, near the valves concerned. In this way the decoupled grid leads may be run below to the power supply and shift controls without shielding or other precautions. Leads carrying the 1000v. C.R.T. supply voltages have been taken through the chassis with small feed-through insulators. If the expense of these is considered too great, rubber grommets could quite well be used for this voltage if the new P.V.C. insulated wire is used, for, although the insulation is quite thin, it is much better than rubber-covered wire of the same over-all size. No layout photograph of the underneath of the bottom chassis has been given, as the placement of parts is not at all critical and can be left to the discretion of the individual builder.

EARTHING OF HEATER WINDING.

It will probably have been noticed that the circuit diagram does not specify exactly how the main heater winding C-C is to be earthed. In the prototype, earthing one side of this winding was tried, but gave a visible 50-cycle hum signal on both axes. Next, a centre-tapped resistor was placed across the winding, and the centre tap connected to the chassis. This effected a great improvement, but a little residual hum was still apparent. The best result in our case was found to be given by connecting the centre-tap of the resistor to the junction of R_8 and R_9, placing the heaters at a quite high positive potential. The hum referred to was shown to arise in the stages with their cathodes above ground—V_4 and V_6. The same cure as applied to the prototype may not be the most effective answer in any 'scope, because of differences in valves. A suggested modification which would be worth trying in a stubborn case is to supply V_4, V_5, and V_6 from the winding A-A that feeds the cathode-coupled stages. The remaining heater windings would then be fed from C-C, one side of which could probably be grounded then without trouble.

SETTING UP THE CONTROLS.

We will assume that the circuit has been completely wired up, and that the initial adjustments are to be made. Before first switching on the power, R_{21}, R_{41}, R_6, R_{11}, R_{13}, and R_{16} should all be set to approximately mid-position. If the last four of these are very far out of adjustment, it is possible that everything could be in order and yet no trace could be seen at all. The X switch, SW_2, should be set to the "Int" position and SW_3 set to one of the middle ranges. The X gain control, R_{31}, should be set to about half-scale.

After turning on the power and being assured that all is well with the power supplies, the brilliance control may be advanced to nearly maximum and the focus control rotated. If the trace is seen it can be focused and then centred with the shift controls. Do not be alarmed if the shift controls will work only on one side of the centre. Proper adjustment later will cure this.

Adjustment is facilitated if a 20,000 ohm per volt meter is available, but as long as its limitations are held in mind, a 1000 ohm per volt meter will suffice. The following procedure will enable the 'scope to be set up if everything is working (i.e., no wiring errors, etc.), whether or not preliminary random adjustment has enabled the trace to be found.

(1) Measure the anode voltages of V_2 and V_3. If they are not equal, adjust the Y shift control till they are.

(2) Do the same for the anodes of V_8 and V_9. These steps may be carried out quite well with the 1000 ohm/volt meter as long as it is on the 500v. range or higher.

(3) Since the effective shift voltages are now zero, the trace or spot should now be centred on the screen. If no spot or trace is visible, the

(Continued on Page 22)

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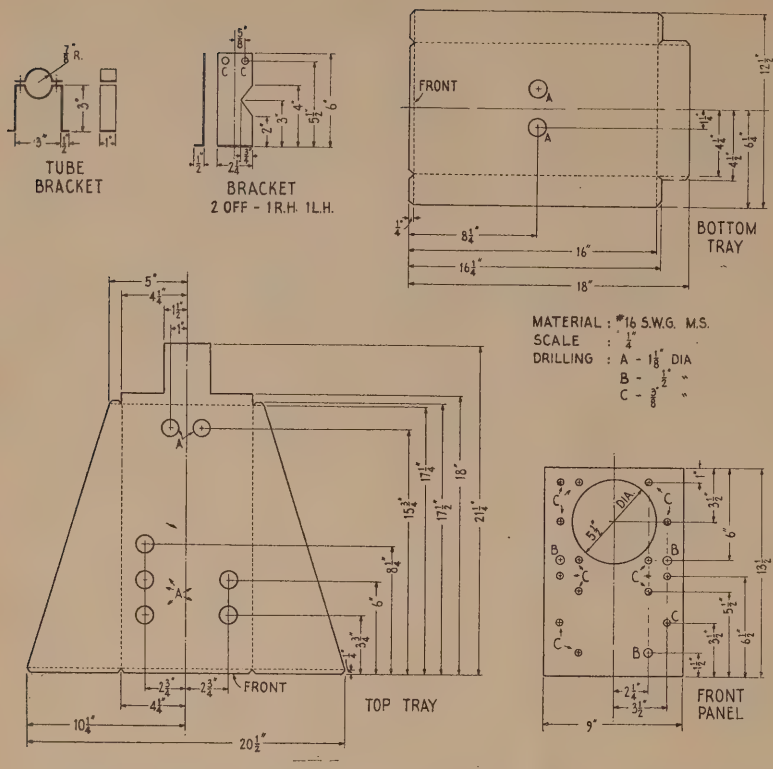

brilliance and focus controls should be adjusted. If it is still impossible to obtain a trace, the C.R.T. power supply circuit should be checked for a possible fault.

(4) Assuming that the spot has been located by the above means, the effect should be tried of fully moving one of the shift controls. In all probability it will be possible to move the spot right off the screen in one direction, but on the other side of the centre, movement will be obtained only over a portion of the screen.

(5) If this is the case, it means that R_{11} is out of adjustment. R_{11} should be moved a fraction of a turn in either direction. This will cause a diagonal movement of the spot at 45 degrees to both X and Y axes. Do not move R_{11} enough to take the spot right off the screen.

(6) Use both shift controls to re-centre the spot, and try step (4) again. If the unequal deflection effect is improved, but still not eliminated, move R_{11} slightly in the same direction as before, and try step (4) again. If the effect is worse instead of better, move R_{11} in the opposite direction to that first tried. By proceeding systematically in this way, a setting will be found for R_{11} that allows the shift controls to operate equally far on each side of the centre. If a 20,000 ohm/volt meter is available, much of this adjustment may be eliminated by setting the tap of R_{11} to + 200v. initially. In any case, final adjustment will have to be made by the method outlined.

If steps (4) to (6) still do not effect a complete cure, the astigmatism controls and R_6 will have to be adjusted. If the 20,000 ohm/volt meter is available, the moving arm of R_6 may be adjusted with its help to the anode voltage of V_2 and V_3 (i.e., when the shift control is set so that the latter are equal in voltage). It should be noted that the adjustment of R_6 and the astigmatism controls is not critical, and that the latter should be set to the same positions at all times. This can easily be done by first adjusting the shift controls, as in step (2) and then adjusting either R_{21} or R_{41} until the anode voltages of V_2, V_3, V_8, and V_9 are all identical.

It will be noted that steps (4) to (6) have been described in reference to one shift control only. This is because the symmetry of the cathode-coupled amplifier circuits ensures that if the X or Y axis shift controls work properly in the manner described, the other will automatically be correct, any difference being due only to slight differences between valves and coupling resistors.

When the oscilloscope has been adjusted thus far it will be possible to use it to display wave-forms on the screen. In order to realise the best possible focus of the picture at all parts of the screen, a few cycles of any suitable wave-form should be used to fill the screen to within half an inch of the edge. Slight adjustments of R_{21} and R_{41} may then be used to sharpen up the picture near the edge of the screen if it is at all out of focus there while sharp in the centre. It may also be advisable to try small adjustments to R_6 in this connection, but this should not be overdone, as it may throw out the adjustment of R_{11}, which would then have to be done all over again.

(continued on page 33)

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DATE: 1st JUNE, 1946

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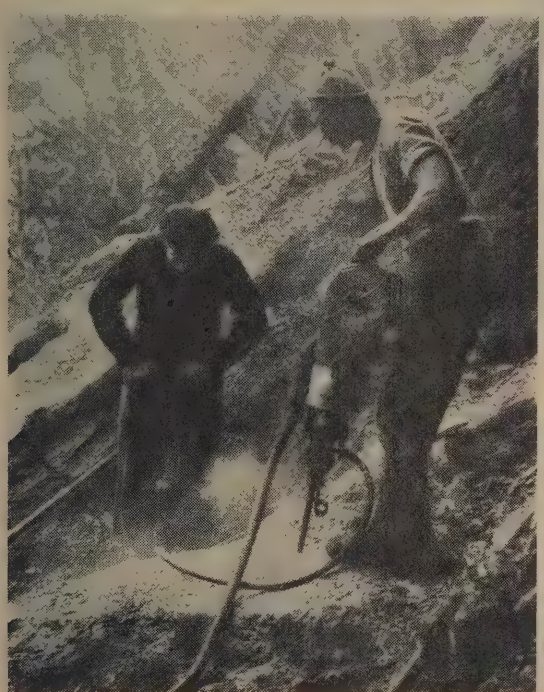
Mica Mining

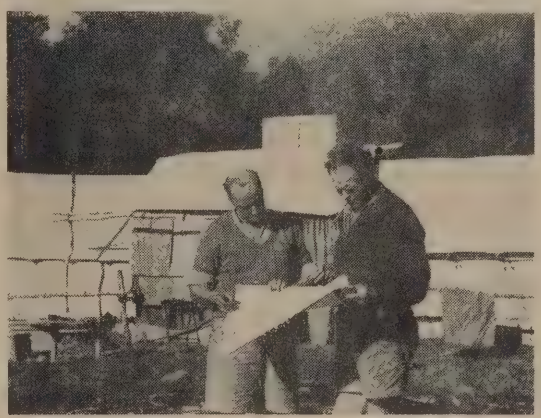
By W. F. HEINZ.

Towards the end of 1943, when the New Zealand radio industry was operating at unprecedented levels of production on current war contracts, the supply of mica condensers failed entirely. Despite the efforts of Government representatives overseas, supply authorities in Britain and America were not able to divert any of their already depleted stocks to New Zealand. For a time, Radio Corporation of New Zealand, Ltd., managed to hold the fort with the facilities and supplies for mica condenser production which they had established in pre-war years. However, worse was soon to follow. High-grade mica, which had become a top-ranking critical material in the Allied countries, was unobtainable, and once again disaster loomed for the projects upon which our industry was engaged.



Such were the circumstances that drove us to explore the seemingly forlorn prospect of the Southern Alps and to defy the snow and ice of the winter of 1944. Information was somewhat scanty, but it was known that there was mica in the Alps, and the Department of Geological Survey immediately marshalled its knowledge of the territory and placed the services of Mr. H. Welman at the disposal of the venture.

In May, 1944, a party was assembled in Greymouth, and on June 3rd it proceeded south to Mahitahi through heavy snow that extended almost to the coastline. At Paringa, where the



road terminates, packing arrangements were finalised and the party continued via the Haast Track, the members walking and leading five pack-horses along 16 miles of track to a location at 1720 feet, where a base camp was established. Beyond this point pack-horses could not proceed, and it became necessary to climb with packs through the snow-clad bush to a level of 3200 feet on the summit of the Mataketake Range. Here a working camp was established adjacent to a disused mica claim, but it proved impossible to live at this altitude under the prevailing weather conditions.

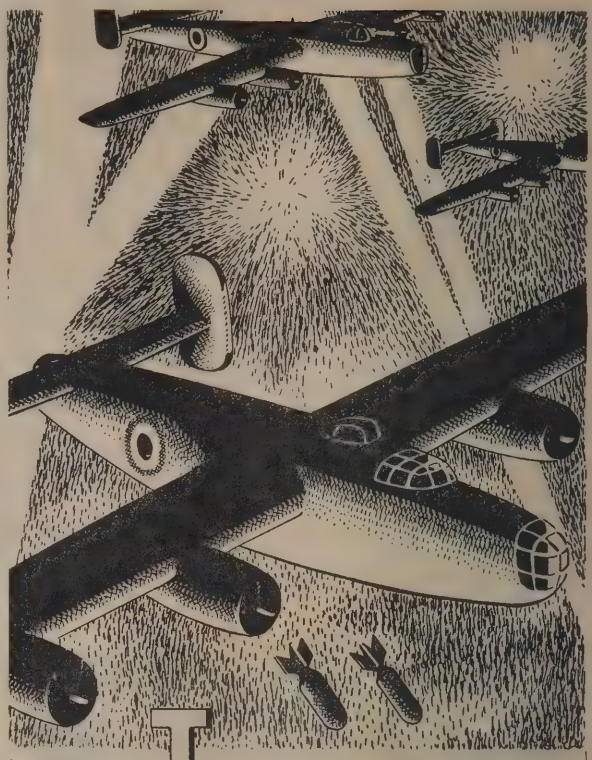
Operations were therefore commenced from the base camp at 1700 feet, involving a 90-minute climb to the summit claim each morning (or, rather, on those mornings when weather permitted climbing). By digging through the snow, a vein of quartz containing mica was eventually exposed, and a limited quantity of small but usable mica was extracted. In all this effort, extending over seven weeks, about 50lb of usable mica was extracted before conditions became intolerable for work.

It became obvious that a fresh area at lower altitude would have to be found, and survey was undertaken of the Blue River Gorge, about four miles back on the Haast Track. It was found that the mica-bearing quartz extended from the Ma-

taketake Summit into the gorge of the river, and a workable deposit was found at 1600 feet altitude. Fortunately the deposit was located in birch bush, which protected the area from the worst snow conditions. With the winter season drawing to a close, work at this claim proceeded with greater success, and in a period of close on 12 months the area yielded about 1200lb of usable mica.

From this venture some definite facts emerge. There is mica in the Southern Alps in veins extending for close on 40 miles. Much of the mica deposit is distorted owing to upthrust of the surface of the country (presumably the result of centuries of pressure from glacial ice), and this has had the effect of cracking and warping the mica sheets. Therefore, although large sheets may be obtained, their usefulness is limited to projects which require only small pieces of mica. In this respect the mica proved admirable for the leaves required in mica condensers, but irregularities in the sheet rule out its usefulness for general electrical purposes. It is considered that deeper mining with mechanical appliances would produce a better quality sheet, since distortion of the quartz vein is likely to be less at deeper levels than at surface level. But in its present stage of development the country is quite unsuitable for mechanical operation on the scale required for deep mining. Road access ceases at Paringa, and thereafter for 12 miles to the Blue River deposit the country is rough and rugged in the extreme. Everything has to be packed by horse and man-power, but there still remains, even under the best of circumstances, a distance of two miles that can be covered only by men, as the steepness of the country defeats horses.

For profitable operation to be maintained, tremendous capital expenditure would first have to be sunk into opening up the country—perhaps one day this may come to pass.



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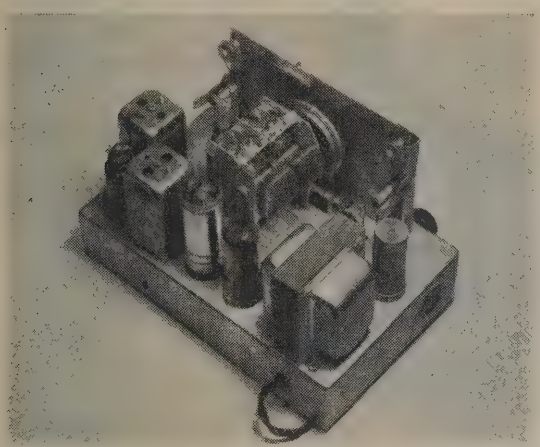
This set is an excellent performer from all points of view. It possesses ample sensitivity, good audio quality, and high power output. It is simple to construct using as it does no more components than are strictly necessary.

Many home constructors have been awaiting the appearance of a modern five-valve broadcast receiver that may be easily constructed from parts available to-day and at reasonable cost. This one we think fills the bill admirably. "Radio and Electronics" has no hesitation in recommending it to seasoned set-builder and novice alike. There are very few things that can go wrong with this set if all components and valves are as they should be, and no one who can make a neat job with the soldering iron should have any difficulty in constructing it or making it work.



THE CIRCUIT.

The first valve is a 6A8 or 6K8, combining the functions of oscillator and mixer. Next comes a 6K7 as an I.F. amplifier, followed by a 6Q7-GT. The latter uses one diode for the second detector, the other as A.V.C. rectifier, and the triode as the first audio stage. The output tube is a 6V6-GT beam-tetrode, and the rectifier a 6X5-GT.

THE 6Q7 CIRCUIT.

In this set, the second detector-A.V.C. circuit is specially worthy of note, as this particular arrangement does much to lift the set's performance out of the average. The two diodes are used quite separately, and in a manner which improves the A.V.C. action and minimises detector distortion. The A.V.C. diode, it will be seen, is fed through a .0001 μf. condenser straight from the plate of the 6K7 I.F. stage. This connection is much better than those which feed this diode from the secondary of the last I.F. transformer. The R.F. voltage fed to the rectifier is greater with this circuit and gives improved control. This connection also prevents altogether the violent hiss that is apt to occur when the set is being tuned on to a station. In addition, it almost eliminates A.V.C. loading of the I.F. transformer secondary, with consequent improvement in audio quality.

Also noteworthy is the use of the detector diode load as the manual volume control. It has long been recognised by set designers that this practice minimises distortion arising in the diode detector, but not very many commercial sets have used it in the past, because if a volume control is inclined to be noisy in action it shows up worst in this circuit. Now, however, one of the largest and best-known manufacturers in this country uses the circuit in at least two current models, which testifies to the noiselessness of the circuit. It was felt that the constructor would in any event prefer an improved circuit, even if it might mean the replacement at some time or another of the volume control potentiometer.

TONE CONTROL.

The tone-control circuit may be new to many. It is one which has been used in a number of commercial sets with very good results. It consists of the .00025 μf. condenser connected to the .5 meg. potentiometer which is the grid resistor for the output stage. When the moving arm of the potentiometer is at the earthed end, the .00025 μf. condensed is connected between 6V6 plate and earth. This position gives maximum brilliance, because only the very high notes are by-passed. When the arm is at the grid end, however, there is negative feedback from plate to grid of the 6V6 through the condenser. Since the condenser passes the higher audio frequencies much more efficiently than it does the lower ones, there is much more feedback at high frequencies than at low. This causes a reduction in gain which is less at low frequencies than at high frequencies, so that the effect is that of boosting the bass response of the set. At points intermediate between these two extremes, the effect of the control is

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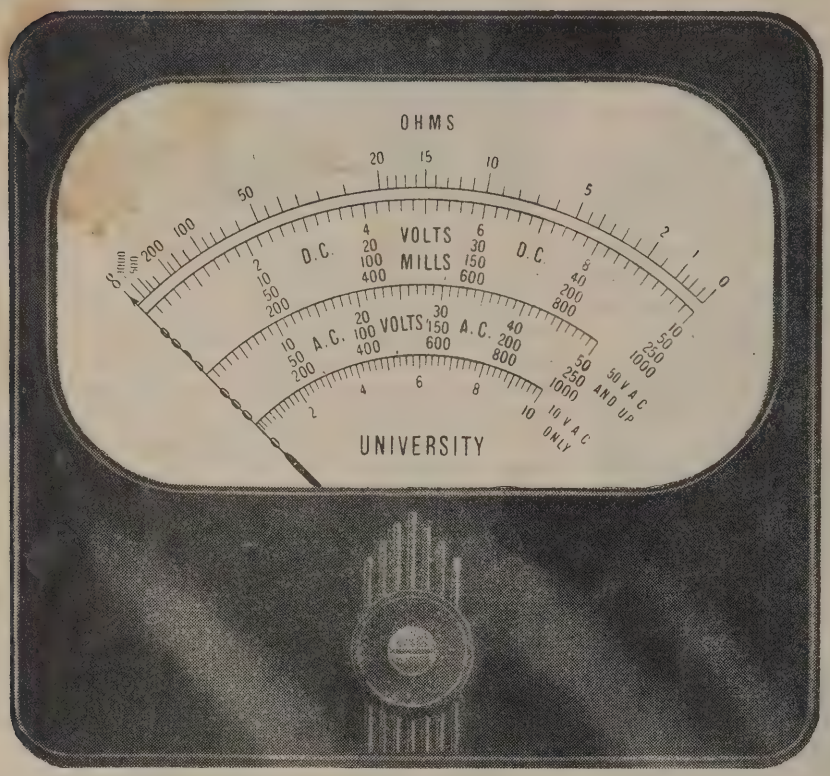

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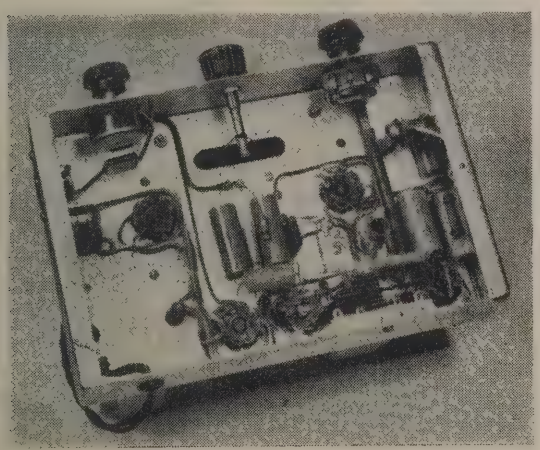
intermediate, so that a tonal balance to suit the individual listener can readily be obtained.

THE RECTIFIER.

In the circuit we have shown a 6X5-GT in preference to the more usual 80 or 5Y3-G. The reason for this is as follows: The latter tubes are somewhat scarce at the moment, but there is a plentiful supply of 6X5's. Some dealers have stocks of one of these three tubes rather than the other two, and will wish to supply the tube they have most of, naturally enough. So, if you go to a dealer for a kit of parts for this set, do not mind which rectifier he supplies, as long as the associated components suit. For instance, the 80 requires a four-pin socket, but the other two use an octal. But whatever happens, make sure that the transformer supplied to use with a 6X5 is suitable for it. This tube has a 6.3v. heater, while the other tubes use 5v. on their filaments. The 6X5 is specially constructed so that a separate heater winding is unnecessary, as shown in our circuit. Its heater is connected in parallel with all the others in the set, the tube being designed to withstand a maximum of 450 volts between heater and cathode. So far, so good, but the 6X5 has a maximum of 325 volts A.C. which may be applied to its plates, so that a 385 v.-a-side transformer cannot be used with it.

The constructor should therefore be supplied with a 325 v.-a-side transformer, with a single 6.3v. heater winding if he is to use the 6X5-GT, but with a normal power transformer having a five-volt rectifier winding as well as the heater and H.T. windings if he is to use an 80 or 5Y3-G.



SPEAKER FIELD.

It will be noted that on the circuit diagram, the resistance of the speaker field winding has not been specified.

For the arrangements where a 385v. transformer is used with an 80 or 5Y3-G, the field resistance should be 2500 ohms.

For the 6X5 and the 325v. transformer, a 2000 ohm field should, if possible, be used. This will give almost the same H.T. voltage as the former arrangement, with no noticeable difference in performance. The higher resistance field can, of course, be used with the 6X5 if desired, but at the expense of reduced output power.

THE OSCILLATOR-MIXER TUBE.

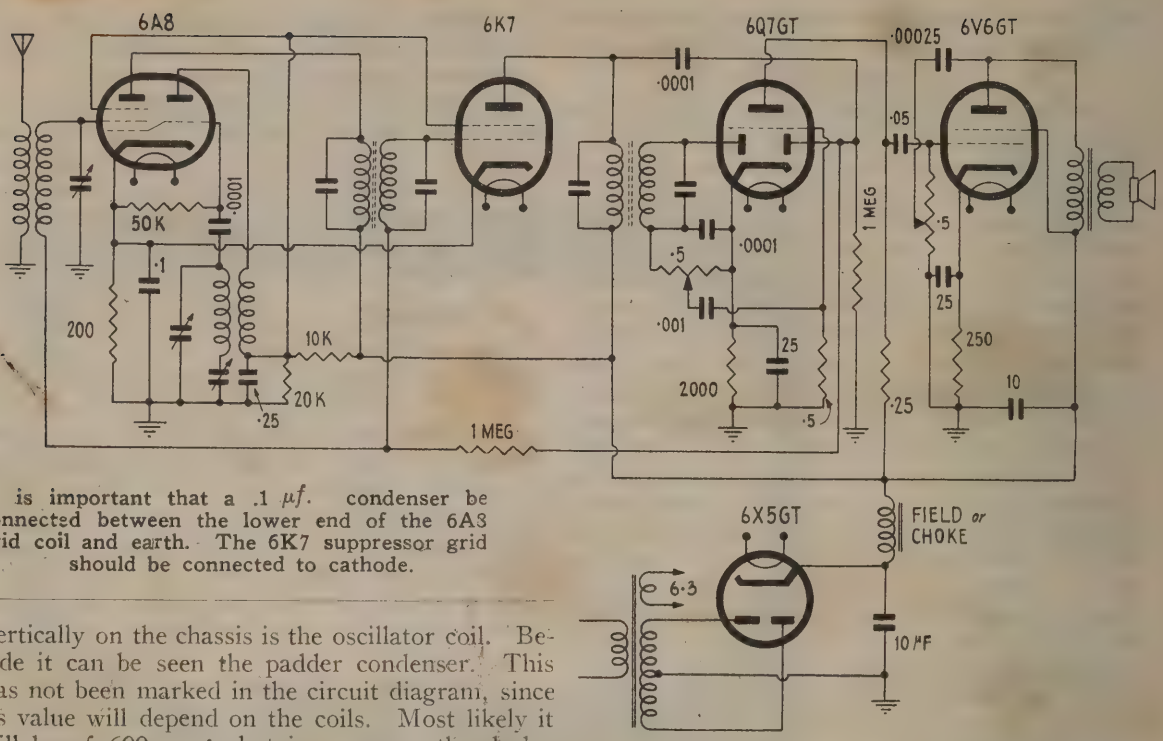
In our circuit diagram we have specified a 6A8 in this position. Here again the supply problem may be difficult, and here the alternative is a 6K8. The same circuit diagram serves for both types, either of which will give satisfactory performance. The choice of one or the other of these valves should be dependent on the coils supplied. Coils designed for a 6A8 are not necessarily satisfactory if used with a 6K8, and vice versa, so that in buying the parts the builder should make sure he gets the valve appropriate to the coils supplied.

The same word of warning also applies to the gang-condenser. Coils are designed for use with a particular type of gang-condenser, and unless this is used the band-coverage may not be correct. It is believed that in some quarters two-gang condensers are in short supply, but that need not be an insuperable obstacle, since three-gang condensers are available and one section may be left unused.

CONSTRUCTIONAL POINTS.

The photographs show quite clearly how the parts are laid out on the chassis, which is 7in x 10in x 2in. The gang-condenser is mounted centrally, and just far enough back to accommodate the dial and condenser. To the right (from the front) of the gang is the mixer tube, while in the corner of the chassis is the I.F. stage. Then, along the back of the chassis, are the second I.F. transformer, the 6Q7-GT and the output tube. The rectifier and dual 10 *μf.* smoothing condenser may be seen in front of the power transformer. No fixed chassis dimensions have been given in this article, as differences in the power transformer dial and gang-condenser will probably necessitate slightly different chassis arrangements, even though the general layout shown here may be adhered to.

The neat point-to-point wiring under the chassis should be noted, as should the mounting of aerial and oscillator coils. The coil at the side of the chassis is the aerial coil, and the one mounted



It is important that a .1 μf. condenser be connected between the lower end of the 6A8 grid coil and earth. The 6K7 suppressor grid should be connected to cathode.

vertically on the chassis is the oscillator coil. Beside it can be seen the padder condenser. This has not been marked in the circuit diagram, since its value will depend on the coils. Most likely it will be of 600 $\mu\mu f$., but in any case the dealer will supply one of the right value for his make of coil. The volume control potentiometer is the one near to the aerial coil, while that on the other side of the chassis is the tone-control. The signal leads to the volume control are run in shielding braid, which is surrounded by a peice of "sphaghetti" tubing to prevent the braid from shorting any of the nearby contacts. At the back of the chassis is a small board with four insulated terminals. This is used to terminate the .004 μf. coupling condenser to the 6Q7 grid, and the shielded leads to the volume control, since there are no convenient valve socket pins for these points of the circuit.

LINING UP THE SET.

When construction has been completed, it is essential to check over the wiring to make sure that no mistakes have been made. If these are fixed before the set is switched on, endless trouble will be saved. In particular, it should be seen to that the proper connections have been made to the oscillator coil, according to the maker's specifications, for if there is a mistake here the set will be as dead as the proverbial doornail, due to the oscillator being inoperative.

However, assuming that the wiring is correct, the final step in the construction is the lining up. Some constructors will prefer to take their set to a serviceman who has the necessary oscillator, etc., but there is no reason why the constructor himself cannot align the set quite well without any instruments other than a screwdriver if the instructions we are about to give are carefully followed.

The I.F. transformers should come from the manufacturer sufficiently closely adjusted to the correct frequency for at least some signal to be heard if the set is all in order except for adjustments. Thus, the first step is to leave the I.F. trimmers severely alone, and to set the trimmers and padder at approximately half-way positions. Turn up the volume, hold the aerial lead in one hand, and tune the set until some signal is heard. If a local station is heard at several points on the dial, do not worry. Having heard a signal, see if it can be heard without anything connected to the aerial lead. If it can, the next step may be proceeded with. If not, use a few feet of wire for an aerial until it can be picked up. The next step is to adjust the I.F. trimmers until the signal is loudest. One should leave the second detector trimmer at first and start with the I.F. plate trimmer, adjusting it for maximum signal. Then adjust the I.F. grid trimmer and finally the mixer plate trimmer. After the first one or two have been adjusted, it may be possible to reduce the

size of the "aerial" used. The set should always be adjusted using the smallest possible signal, and, once you have started to adjust the I.F. trimmers, on no account touch the tuning control until this is finished.

When a preliminary adjustment of the first three I.F. trimmers has been made, try if adjusting the second detector trimmer will improve the signal output, and, if so, adjust it also for maximum signal.

Now we are ready to adjust the aerial trimmer and the oscillator trimmer and padder. By this time it may be possible to hear several stations if an aerial is connected to the set. Select one near the opened position of the tuning condensers, and adjust the aerial trimmer to give maximum signal. If no optimum position can be found on this trimmer, try increasing or decreasing the setting of the oscillator trimmer. This will necessitate re-tuning slightly to find the station again. This done, try the aerial trimmer again. If still not successful in finding a peak on this trimmer, readjust the oscillator trimmer, tune in the station again, and try again. If a peak signal can be obtained by adjusting the aerial trimmer, set the latter to this position and tune in on a station on the low frequency end of the condensers. IYA or 2YA is the best to use, but for a preliminary adjustment of the padder, any station up that way will do. Adjusting the padder will tune the station in and out, so that to find the best adjustment for this control it is necessary to "chase" the signal over the dial with the main tuning condensers. Perhaps the easiest way is to make a small adjustment to the padder, tune in properly with the gang and note the result. Move the padder some more, retune again, and note wether the signal is better or weaker. If better, continue moving the padder step by step in the same direction and retuning each time until a stage is reached where continuing the process starts to weaken the signal. If the first padder adjustment weakens the signal after it has been retuned, the proper padder setting must lie in the opposite direction, and the process should be carried on, as explained, until the best position is found. When the padder is properly adjusted, moving it either way will result in a weaker signal after the main dial has been re-tuned.

With the padder adjusted in this way, turn back to the high frequency end of the band to the station which was used to adjust the aerial trimmer, and give the latter a final adjustment.

(Continued on page 35.)

"RAYMART"—a name to remember

OUR FIRST SHIPMENT OF THESE HIGH-GRADE BRITISH COMPONENTS HAS ARRIVED AND WE OFFER:

Ceramic insulated, single ball-bearing, Midget Variables 15mmfd., 6/6; 40mmfd., 7/-; 100mmfd., 8/6; 160mmfd., 10/6; 250mmfd., 12/6; 15mmfd. 21in. spacing for neutralising, 7/-; 40mmfd. 21in. spacing for transmitting, 9/-.

Coil Formers, RD4 insulation Plug-in type to fit English Sockets, 4-pin plain, 3/6; 4-pin threaded, 4/-; 6-pin plain, 3/10; 6-pin threaded, 4/4 (diameter 1½ inches).

Sockets for above—4-pin, 2/-; 6-pin, 3/-.

Ceramic Valve Sockets—4, 5, and 7-pin, 2/6; Octal, 3/-.

Feed-through Bushes, a two-piece Ceramic Bush for high-frequency or high-voltage use or to mount components above a metal chassis—
Large, 8d each or 7/6 dozen
Small, 7d each or 6/6 dozen

Insulated Pillars 1⅜in. by ⅜in. threaded with screws each end, 1/8.

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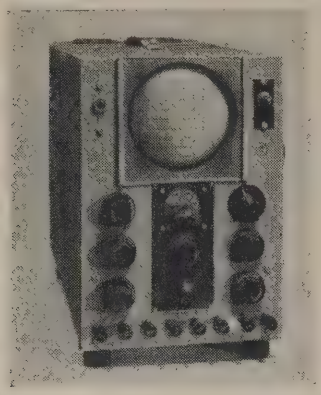

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PRICE £75-0-0 plus Sales Tax.

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TIME BASE . . . 5 – 250,000 c.p.s.

AMPLIFIER		Gain	Frequency Band in c.p.s. – 3 D.B.	Sensitivity mV.RMS/mm
1 stage		28	10 — 100,000	43.0
2 stage	High Gain	900	10 — 100,000	1.3
	Wide Band	106	10 — 2,000,000	10.0

RADIO

Where a **DOUBLE BEAM** Tube is advantageous or essential.

Aligning band-pass intermediate and radio frequency circuits in Radio Receivers.
Tracking of oscillator and pre-selector circuits in superhets.
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Comparison between the input and output of amplifiers and networks without the need of a pure signal source.
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Frequency doubling and Monitoring tests on Radio Transmitters.
Matching of radio coils, R.F., I.F., etc.
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Comparative observation of related wave-forms.
Comparative band-width measurements.
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Adjustment of phase splitting circuits in both transformer and valve-coupled stages.
Testing and adjusting of push-pull and other types of symmetrical circuits.
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Testing amplifiers by application of transients (square wave-forms).

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OUR GOSSIP COLUMN

Mr. Charles E. Forrest.

Mr. Charles E. Forrest, Managing Director of International Radio Co., Ltd., for Australasia, left Australia for America, Canada, and the United Kingdom. While abroad Mr. Forrest will study methods of cable manufacture and at the same time will make arrangements for two new industries his company is undertaking in both Australia and New Zealand.

Mr. Toby Halliday, who for some years past had been sales engineer with the Enfield Cable Co., England, and who accompanied Lord Forrester on part of his Australian tour, joined International Radio on May 1.

* * *

Mr. J. R. Robertson, Director and New Zealand Manager, has been well occupied in increasing production to satisfy cable orders and in supervising the installation of new machinery.

* * *

C. R. Dahlberg, of Wairarapa Radios, Ltd., Masterton, has now extended his activities to Carterton, where an attractive branch shop has been opened, piloted by W. D. Young, ex R.N.Z.A.F.

* * *

George Ferris, Christchurch representative for Radio (1936), Ltd., was seen in Wellington recently, just for a hit-and-run one-day trip. We were pleased to see that George still wears his cheerful smile after five years' military service. A keen dry-fly angler we expect many less proficient in the art will be wending their way south this season to benefit from George's expert knowledge.

* * *

Ken Blenkarne arrived in Wellington recently to take charge of the local branch of P. C. Blenkarne, Ltd. Ken's main work has been to locate larger premises, made necessary by greatly increased business.

* * *

J. Carr has resumed his position with National Carbon Pty., Ltd., after four years with the army. Welcome back, Jack.

We should very much like to know what is in all the parcels Rex Lulham, of National Carbon Pty., Ltd., takes home with him. What about an invitation to the party? Still, maybe it's only paint.

* * *

Mr. Emeny, Turnbull and Jones field representative, has been renewing contacts in the Waraipara territory.

* * *

Reg Borham, of S.O.S. Radio Service, Auckland, has been in the South Island on business connected with his firm. On his way back to Auckland he spent a few days in Wellington. We understand Reg's opinion of accommodation in the Capital City is well below par.

* * *

Callers to "Radio and Electronics" office while on business in Wellington were Mr. R. N. Roberts, of Roberts Radio Service, Auckland, and Mr. Colin Cross, of Judd's Radio, Tauranga.

* * *

Mr. Eric Undrill, chief engineer of Philips Radio Factory, is due to leave New Zealand almost immediately on an extended visit to the Philips factories in Holland, England, and Canada. The purpose of his visit is to obtain modern design data for use in the New Zealand organisation's future production.

* * *

Another well-known manufacturer at present in England is Mr. P. C. Collier, of Collier and Beale, who is making a general investigation of electronic developments.

* * *

Wing-Commander L. F. Taylor wins a toffee-apple for this month's best "line." While discussing the excellent D.F. service he was getting from New Plymouth during a sticky trip from there to Wellington, he concluded by stating, "Although the fixes I obtained were really good, it did not matter much as the clouds were so thick I could have landed on them."

The First of the Few !

"Celestion" Model P64

- Twelve-inch P.M. Speaker.
- Power Handling Capacity, 15 watts.
- Impedance, 15 ohms.
- Voice Coil, 1¾ inches.
- Total Flux, 135,000 lines.

Price £12-12-0

(includes tax)

GREEN and COOPER

43 TARANAKI STREET, WELLINGTON.

This page is contributed monthly by the New Zealand DX Radio Association (Inc.), 20 Marion Street, C.2, Wellington, New Zealand. All "DX" and Club enquiries should be addressed direct to the Association.

THIS "DX-ING

4.95 mcs.—VQ7LO, Nairobi (1500 watts) has been heard as early as 4 a.m. Sometimes fair 6-7 a.m. with local news in English at 6.25 a.m. and foreign news in English at 6.55 a.m.

6.01 mcs.—OLR2A, Prague, has a daily English half-hour 8-8.30 a.m., with news followed by talks on Czech and Slovakian affairs.

6.09 mcs.—Radio Luxembourg can be heard with a request programme to England on Mondays from 7-8 a.m. Both male and female announcers are used and titles of records played are usually given in English; otherwise own language is used.

9.37 mcs.—Radio National Espana. Good sig. at 7.45 a.m. News 8 a.m.

9.44 mcs.—FZI, Brazzaville, has English sessions at 8.45 a.m. and 10.15 a.m. These programmes may also be heard on 11.97 mcs.

9.57 mcs.— ZBW, Hong Kong (was on 9.47 mcs), last known schedule is 9.30-11.20 p.m. and midnight on. Relays BBC news at 11 p.m. but has bad interference from San Francisco.

9.695 mcs.—XUPA location uncertain, but thought to be Formosa; has XGOY news at 2 a.m.

9.75 mcs.—KWIX, San Francisco, good in AFRS service at 4 p.m.

9.85 mcs.—KWID, San Francisco, good from 11 p.m.

9.958 mcs.—HCJB, Quito, Ecuador, is good when opening at 10.45 p.m. in English; very good in early p.m.'s until sign-off at 3.30 p.m. In parallel with 12.455 mcs.

11.3 mcs.—WCRC, New York. News at 9.15 a.m.

11.71 mcs.—XORA has moved here from 11.685 mcs. some time ago. Good in evenings, with a swing session at 10.45 p.m. and English news at 11 p.m. American announcers are used.

11.78 mcs.—Radio Saigon is on the air daily from 3.30-4.45 p.m. and from 7 p.m. to 2.15 a.m. Good in English 10.15-10.30 p.m. and from 1.30-2.15 a.m.; otherwise in Indo-Chinese.

11.83 mcs.—VLW3, Perth, operates 3.30-10.15 p.m. (Sunday 4-11.15 p.m.); fair signal from 8 p.m. on, but suffers from morse interference.

11.85 mcs.— Radio Rangoon, Burma, has English news at 1.45 a.m. and is a good signal until closing at 3.15 a.m.

15.09 mcs.—CKLX, Montreal, a new CBC station, operates in parallel with CKNC (17.82 mcs.) from 11 p.m. to 1 a.m. and from 4 a.m. to 10.15 a.m. to Europe. Sunday schedule is 11 p.m. to 10.03 a.m.

15.22 mcs.—"The Voice of Indonesia," Bandoeng, Java, broadcasts in various languages and sometimes has English news at midnight.

15.23 mcs.—KGEI, San Francisco; good in AFRS at 4 p.m.

15.29 mcs.— WRUL, New York; good musical programme at 10 a.m.

17.80 mcs.—KRHO, Honolulu; AFRS programme at 11 a.m.

21.65 mcs.—WLWS2, Cincinnati, beams to North Africa 12.30-5.45 a.m. in English and various other languages.

MOSCOW.

12.11 mcs.—12.45 a.m. to 1.15 p.m., plenty of English.

11.83 mcs.—English news at 6.30 p.m.

9.60 mcs.—English news at 11.45 p.m. and 12.30 a.m.

9.565 mcs.—English news at 12.45 a.m.

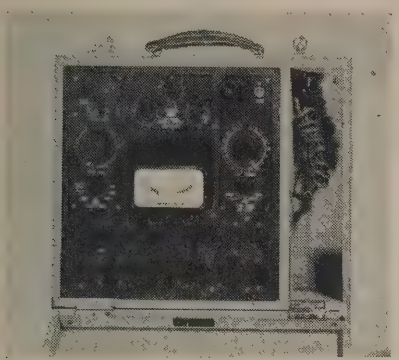
9.48 mcs.—English news at 6.30 p.m.

* * *

OFFICIAL OVERSEAS SCHEDULES OF AUSTRALIAN SHORTWAVE STATIONS IN ENGLISH AS AT 1st APRIL, 1946.

Country.	N.Z.D.S.T.	Trans.	Freq. kc/s.
Great Britain	8.00 p.m.— 8.53 p.m.	VLC.8	7280
	3.15 a.m.— 3.45 a.m.	VLC.8	7280
	,,	VLA.3	9680
	,,	VLG	9580
U.S.A.	5.00 p.m.— 5.45 p.m.	VLG.6	15230
	,,	VLC.4	15315
	1.00 a.m.— 1.50 a.m.	VLC.5	9540
	4.00 a.m.— 4.55 a.m.	VLG.4	11840
	,,	VLC.6	9615
	11.40 a.m.— 1.50 p.m.	VLC.9	17840
	(Test only.)	do.	do.
	10.30 p.m.—10.50 p.m.	do.	do.
	12.30 p.m.—12.45 p.m.	VLG.3	11710
	9.00 p.m.—10.00 p.m.	VLC.6	9615
	,,	VLA	7280
	12.45 p.m.— 1.35 a.m.	VLG.3	11710
	,,	VLA	7280
	1.35 a.m.— 2.00 a.m.	VLG.3	11710
	,,	VLC.6	9615
	2.00 a.m.— 2.15 a.m.	VLA	7280
	,,	VLG	9580
	,,	VLC.6	9615
	,,	VLA	7280
	,,	VLA	7280
Asia, India	2.30 a.m.— 2.45 a.m.	VLG	9580
	,,	VLC.6	9615
	,,	VLG	9580
India	2.45 a.m.— 3.00 a.m.	VLC.6	9615
	,,	VLA.6	15200
Forces Programme	9.15 a.m.—11.00 a.m.	VLA.6	15200
	9.55 a.m. (Sun.)	VLG.3	15230
	2.00 p.m.— 4.00 p.m.	VLC.4	15315
	3.45 p.m.— 7.25 p.m.	VLA.6	15200
	(Saturdays only.)	VLA.6	15200
	8.35 p.m —12.15 p.m.		

TAYLOR PRECISION INSTRUMENTS



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- The meter has a sensitivity of 250μA full scale deflection and comprises three scales. The first measures mutual conductance. The second marked Good, ? and Replace. The third is used for checking emission of diodes and rectifiers.
- The tester has sixteen valve holders covering all usual English, American and Continental valves. Filament voltages can be selected in seventeen steps from 1.1 to 117 volts.
- Available in two models:

Bench Instrument - £40-18-2 includes Sales Tax.
Portable Instrument - £45-2-10 includes Sales Tax.

TAYLOR SIGNAL GENERATOR SPECIFICATIONS:

- A highly accurate instrument with a frequency range of 100 kc/s to 46 mc/s.
- R.F. output is variable up to 100 mv. and controlled by two attenuators—one coarse and one fine.
- Internal modulation is available at 400 c.p.s. and when switch is turned to ext. mod. a good waveform of 400 c.p.s. is available for external work. Output may be varied up to 1 volt.

Price, £32/8/1 (includes sales tax).

HOHNER ELECTRICAL CO.

11 Herbert Street — Wellington.
(P.O. Box 192 Te Aro)

The Radel Five

(*Continued from page* 31.)

ADJUSTING THE DIAL.

If a calibrated dial has been supplied with the coils and condenser gang, this should be the last thing to be adjusted, after the foregoing procedure has been completed. To do this, tune in a known station, slacken off the nut holding the condenser shaft, and, *without moving the condenser vanes,* turn the dial till the pointer indicates the frequency of the station that has been tuned in. Tighten the screw holding the condenser and the job is done. The pointer should now indicate the correct frequency all over the scale. Exact calibration can not, of course, be expected, but if it is a very long way out, the most likely cause is that the I.F. transformers are not adjusted to the correct frequency. Again alignment with a signal generator is the cure.

If no position of the oscillator trimmer can be found which enables a peak adjustment to be found on the aerial trimmer, either the coils will not track properly, or else the I.F. transformers, though adjusted, are tuned to an incorrect I.F. If this behaviour is obtained, the constructor is well advised to take the set to a serviceman, who will align it properly with a signal generator and can then say whether the coils are tracking properly or not.

TRADE WINDS

Recording enthusiasts will undoubtedly be pleased to know that General Electric Co. U.S.A. Wire Recorder will shortly be available in New Zealand.

The G.E. magnetic-wire Recorder is an electronic device capable of recording and reproducing sound and speech on wire . The recordings may be kept as permanent record or "erased" magnetically. The recording head is a magnet specially designed to form a magnetic pattern of the sound as the wire passes through the field of the head.

The recording wire which is drawn and quenched carbon steel, 0.004 inches in diameter, is driven from one spool to another through the recording head by means of a two-speed motor which can be reversed for re-winding purposes. The spool contains 12,000 feet of wire, which is sufficient for continuous use for 33 minutes at high speed, or 66 minutes at low speed. The lower speed is usually used for speech and sound effects; the higher, for use where higher fidelity recording is required.

An outstanding advantage of the wire recorder is its erasure feature, which is accomplished by passing a high-frequency voltage through the demagnetiser, thereby leaving the wire magnetically neutral when it enters the recording head.

The frequency range is 200 to 3000 c.p.s. with the wire travelling at half speed, and 200 to 5000 c.p.s. at full speed.

Any further information on this G.E. instrument may be obtained from the New Zealand agents, the National Electrical and Engineering Co., Ltd.

* * *

Philips Lamps (N.Z.), Ltd., advise us that the name of the company has been changed, and in future will be known as Philips Electrical Industries of New Zealand, Ltd. The head office, service department, and store continue to be located at Nimmo's Building, corner of Willis and Bond Streets, Wellington. The apparatus factory continues to be located at 181-195 Wakefield Street, Wellington. Please continue to address all mail to the company to G.P.O. Box 1673, Wellington. Telegraphic address, Argenta, Wellington. Telephone numbers have been changed and are now 45-857 and 45-858.

* * *

(Extract from "Radio and Electrical Retailer," March 28, 1946.)

EVEREADY BATTERIES USED ON PROXIMITY FUSE.

Readers of this journal, many of whom use Eveready batteries, will be interested to know that National Carbon Company, parent company of the New Zealand company, National Carbon Pty., Ltd., developed the designs used for 85 per cent. of the 30,000,000 special Eveready "Mini-Max" batteries produced for V.T. proximity fuses, and manufactured 22,500,000, or 75 per cent., of this total. Production of the dry battery type started in January, 1942, and 3,668,000 batteries, containing 234,689,000 cells, were made. The "wet," or "reserve," type inert battery was developed by the National Carbon Company, who also produced 18,852,000 batteries of this type. At the end of the war, 8000 men and women were making V.T. proximity fuse batteries in National Carbon Company-operated plants.

Mr. Nelson Jones, Managing-Director of The National Electrical and Engineering Co., Ltd., has just returned to New Zealand after an extended visit to U.K., U.S.A., and Canada. The object of his business trip was in connection with contracts his company has secured for the supply of heavy electrical equipment for the Government hydro scheme at Maraetai. The synchronous condensers are being manufactured by B.T.H. and the transformers and generating equipment by the Canadian General Electric Co.

While in England, Mr. Nelson Jones arrived at the B.T.H. plant at an interesting time. The factory was at the change-over period from war to peace-time production and as B.T.H. were manufacturing electric torpedoes, he had the opportunity of seeing one more of the outstanding engineering contributions which played no little part in winning the war.

The obvious importance of the electric torpedo is due to the fact that it does not identify itself by producing the usual tell-tale wake.

Commenting on conditions in England, Mr. Nelson Jones said, "The clothing ration allows for 16 coupons each year and a man's suit involves 18 coupons—can I say more?"

His visit to the General Electric Co. in U.S.A. was curtailed somewhat due to strikes and it was there that he saw for the first time a strike picket.

In Canada he found the Maraetai plant well advanced and everyone concerned most enthusiastic, both as regards making delivery by the contract date and the excellence of the apparatus being manufactured.

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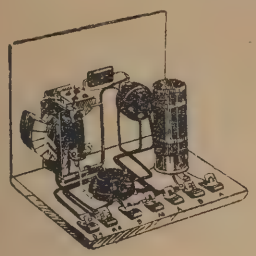

The "IMPROVED HIKERS ONE" RECEIVER

Complete Kit of Parts with Batteries

Cat. No. EK2004 **£2/13/6**

The "Hikers One" KITSET has proved to be one of the most popular Kits we have produced. Hundreds of these little "Battery Misers" are in use every day all over N.Z. This is a very straightforward receiver and can be constructed by the average schoolboy.

Every Kitset is supplied complete to the last nut and bolt together with full constructional details.

The LAMPHOUSE MAIL ORDER SECTION 11 MANNERS ST, WELLINGTON

10-METRE PROPAGATION

(*Continued from page* 16.)

The closer one works to the maximum usable frequency, the less absorption takes place in the ionosphere.

So far nothing has been said about the lowest frequencies that can be used under given conditions. This is partly because the emphasis has been on 10 metres, but also because it is tied up with ionospheric absorption of radio waves. The mechanism of this absorption is quite complex, and has to do with the ionised particles and free electrons in the ionosphere, and the earth's magnetic field as well. The most important thing about it is that it is strongest for the lowest frequencies. In other words, the nearer the operating frequency to the maximum usable, the stronger the signal will be, other factors such as transmitter power being equal. For instance, while the electron density in an ionosphere layer determines the highest frequency that can be used, absorption determines the lowest. A useful working rule is that frequencies lower than 50 per cent. of the maximum usable are not likely to give good communication. This rule is not nearly as well defined as the high-frequency limitation, but serves to illustrate the point. In past years, maximum usable frequencies have seldom risen far above 30 mc/sec., so that when the 10-metre band is "in," it is never far below the M.U.F., and absorption is very low. When the 10-metre band is in operation, "20" will also be "in" for some distances, but if this is the case, a given transmitter power will always give a stronger signal on ten.

Summarising the information we have given more especially about 10-metre propagation, we have the following list:—

(1) The best time for "ten" is at midday, midsummer, at the peak of the 11-year sunspot cycle.

(2) Conditions deteriorate each year until the sunspot-maximum, when they start to pick up again.

(3) Late morning and early afternoon are, in general, the best times of day for 10-metre working.

(4) If a place is being worked on 20 metres, and conditions allow 10 to be used at all, the latter will give a much stronger signal.

(5) For general 10-metre working, an aerial with a main lobe at about 7½ degrees above the

horizontal is the best. Vertical directivity in this way is well worth having, even if no horizontal directivity is used.

(6) Short-distance sky-wave working on 10 is impossible, except under freak conditions.

(7) Short-range work must be confined to line-of-sight conditions, as at higher frequencies.

(8) High power is less of a necessity on 10 metres than on any other band.

5" OSCILLOSCOPE

(*Continued from page 22.*)

THE FOCUS CONTROL.

It should be borne in mind that cathode ray tubes vary in their characteristics just as do ordinary valves. Thus, if the focus control R_{45} does not quite have enough control to attain sharp focus at all settinigs of R_{46}, the addition of, say, half a megohm between R_{45} and R_{46} should be tried; the circuit as printed brings the focus point for some tubes quite close to the end of the movement of R_{45}.

THE BLACK-OUT TUBE.

The adjustment of this circuit has been outlined already. If it causes any trouble, remove the 6SN7 V_{11} + V_{12} from its socket while the above adjustments are in progress, and leave the adjustment of this tube till the last.

THE TIME-BASE TUBE.

It is strongly recommended that the values in this part of the circuit be firmly adhered to, or else trouble in obtaining oscillation may be experienced. The big point here is to have the correct ratio of D.C. screen to plate voltage. If this is not correct, nothing will induce oscillation to start, but, once right, no trouble is experienced at all. Small defects such as non-oscillation at some settings of the fine frequency control R_{34} should be cured by finding a valve which does not give the trouble rather than by varying the resistor values.

10-METRE CONVERTER

(*Continued from page 9.*)

tion, the important thing is to see that the oscillator coil is approximately 2 turns larger than the mixer grid coil. If this precaution is taken it should be entirely practical to gang the tuning condensers. This was not done with the prototype because of the different layout that would be required, and because it is not really necessary with a converter of this sort. The extra adjustment hardly takes any time, and one is never in doubt as to the correct tuning of the mixer. Besides, the mixer selectivity is still not high enough to prevent searching a band of plus or minus ten degrees with the oscillator condenser alone.

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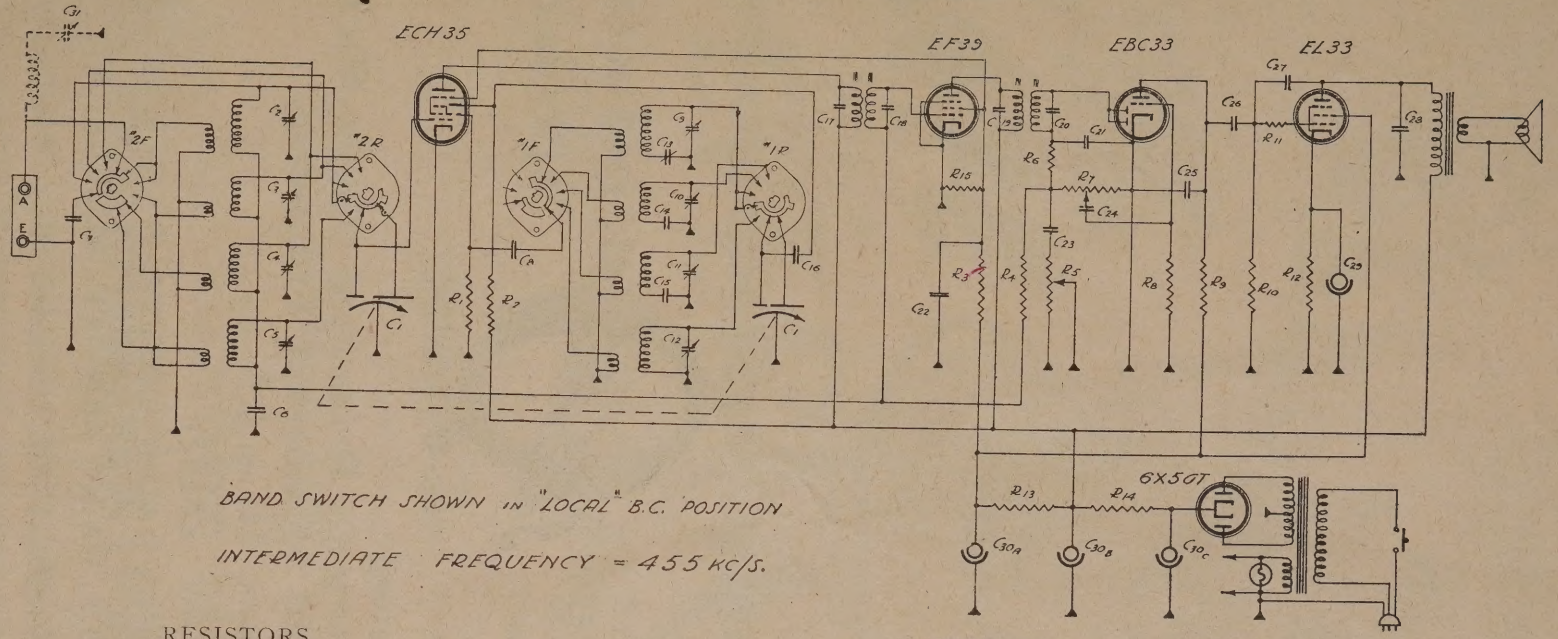

RESISTORS.

R1	47,000	Ohms	⅓ Watt
R2	22,000	Ohms	⅓ Watt
R3	10,000	Ohms	1 Watt
R4	2.2	Megohms	⅓ Watt
R5	2.2	Megohms	(Control)
R6	47,000	Ohms	⅓ Watt
R7	.5	Megohms	(Control)
R8	4.7	Megohms	⅓ Watt
R9	470,000	Ohms	⅓ Watt
R10	470,00	Ohms	⅓ Watt
R11	22,000	Ohms	⅓ Watt
R12	150	Ohms	1 Watt
R13	3,900	Ohms	1 Watt
R14	120+200+470	Ohms	

CONDENSERS.

C1	Gang Condenser			
C2	3—30	mmfd	Trimmer	
C3	1—10	mmfd.	Trimmer	
C4	1—10	mmfd.	Trimmer	
C5	40—70	mmfd.	Trimmer	
C6	.05	mfd.	200 Volt	
C7	2,000	mmfd.	600 Volt	
C8	50	mmfd.		
C9	3—35	mmfd.	Trimmer	
C10	3—35	mmfd.	Trimmer	
C11	50—80	mmfd.	Trimmer	
C12	75—105	mmfd.	Trimmer	
C13	300—720	mmfd.	Padder	
C14	4,000	mmfd.		
C15	5,000	mmfd.		
C16	100	mmfd.		
C17	100	mmfd.		
C18	100	mmfd.		
C19	100	mmfd.		
C20	100	mmfd.		
C21	250	mmfd.		
C22	.05	mfd.		400 Volt
C23	2,000	mmfd.		600 Volt
C24	5,000	mmfd.		600 Volt
C25	250	mmfd.		
C26	.1	mfd		600 Volt
C27	100	mmfd.		
C28	2,000	mmfd.		600 Volt
C29	25	mfd.		50 Volt
C30	40+40+20	mfd.		Electrolytic

VOLTAGE TABLE.

Valve.	Plate	Screen	Cathode	Heater
ECH35	225			
	Osc. 135	100	—	6
EF39	225	100	—	6
EBC33	25	—	—	6
EL33	210	180	4.4	6
6X5	250 AC per Plate		260	6

The voltages given in this table apply when a voltmeter of 1000 ohms per volt is used, the bandswitch being in the broadcast position and no signal input to the receiver. Variations in voltage readings up to 10 per cent. are permissible.

1st I.F. TRANSFORMER
(Type VK476-04)

Plate Coil .... 2—3
Grid Coil ..... Top Cap—1

2nd I.F. TRANSFORMER
(Type VK476-05)

Plate Coil .... 4—1
Diode Coil .... 2—3

INTERNAL CONNECTIONS OF COILS

Aerial Coil (Type VK469-23)
Red Spot on No. 1.

BC { Aerial Coil ..... 3—4
ECH35 Grid Coil 2—6
SW2 { Aerial Coil ..... 8—4
ECH35 Grid Coil 1—5

Aerial Coil (Type VK469-24)
White Spot on No. 1.

SW1 { Aerial Coil ..... 7—6
ECH35 Grid Coil 4—8
SW3 { Aerial Coil ..... 2—6
ECH35 Grid Coil 1—5

Oscillator Coil (Type VK471-04).
Green Spot on No. 1.

BC { Grid Coil .... 4—6
Plate Coil ..... 2—7
SW3 { Grid Coil .... 8—5
Plate Coil ..... 1—5

Oscillator Coil (Type VK471-05).
Blue Spot on No. 1.

SW1 { Grid Coil .... 3—8
Plate Coil ..... 2—6
SW2 { Grid Coil .... 4—8
Plate Coil ..... 1—5

4 m.c. I.F.
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10-Meter Converter

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